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C O N T E N T S

SUBSCRIPTIONS AND TREASURER

The annual subscription rates for 1981 remain unchanged, viz.£6.00 for ordinary membership, £3.00 for junior membership and £1.00 for family membership. The appropriate rate should by now have been paid. North American members should send their subscriptions ($15) to Dr Nancy Slack, Biology Department, Russell Sage College, Troy, NY 12180, who has kindly agreed to act as our American 'Treasurer'. Other foreign, and British, members should send their subscriptions in £ sterling to our Membership Secretary, G.G. Geyman, 48 Gascoigne Gardens, Woodford Green, Essex, IG8 9NU.

Please note that Dr Derek Foster has relinquished the post of Treasurer and should not in future be sent subscriptions as he has also changed his address. The new Treasurer is Michael Pearman, The Library, Chatsworth, Bakewell, Derbyshire, DE4 1PP.

THE SPRING MEETING, 1980, PEMBROKESHIRE

The Spring Meeting in 1980 was held in Pembrokeshire, S. Wales, from 9 to 16 April. As of late, the intention was to cover some of the underworked areas for our Mapping Scheme, and in this were successful. The Society visited the area last in 1958, but this was before bryophyte mapping had started, so on the present trip it was deemed necessary to re-visit some of the localities in the 1958 programme. Headquarters, as then, was the Hotel Mariners in Haverfordwest. As local secretary I was unable to find suitable "institutional" accommodation where we could all stay in the area, so people booked in at various establishments throughout the town and gathered socially in the HQ hotel in the evenings. About 32 people participated, numbers fluctuating throughout the week; we were glad to have with us for most of the time our North American member Dr Nancy Slack. All the localities we visited were in v.c. 45.

10 April. About twelve people turned up at Hook Wood, an ancient sessile oak woodland clothing the steep outer banks of a major meander of the Western Cleddau estuary. One party worked down through it to the shore and then westwards along the base of the wood; another party worked the east end of wood. We found a considerable quantity of Cephalozia media with sporophytes. We thought we had worked the area reasonably well by 11.15 so moved to Ferry Hill, just south of Benton Castle. Here we worked up the inlet from the Daucleddau and then up the stream that flows into it, through deciduous woodland with brambles, and into another 10 Km square. Cephaloziella turneri was on shaded and overhung rocks by the inlet. Everywhere was very acid. The woodland form of Ctenidium molluscum was on rotten bark and on a roadside bank. The party then split up. One group went to Black Bridge, Milford Haven where they worked along a disused railway line and wooded stream towards Waterston. Martin Corley went to the square west of Dale and found Bryum dunense on the cliffs above Marloes Sands and Amblystegium varium in a swamp at Marloes. The rest went to a strip of old oak woodland with a disused railway line running along the river at Neyland. Again the area was very acid; the woodland was bryologically dull and the railway line was not very interesting. A rock face (presumably left by the railway engineers) at the base of the wood had Racomitrium aquaticum and Scapania compacta, and a bank in the wood yielded Pohlia lutescens.

Our party, in an effort to cover as much ground as possible went first to Walwyn's Castle, the site of a motte-and-bailey castle on a steep-sided spur in the valley leading down to Sandy Haven. In a small gulley with elders and a stream, Campylopus introflexus was on a stump with Orthodontium lineare, and Orthotrichum pulchellum and Cryphaea heteromalla were on elders near Syke Farm. Afterward, the south side of Sutton Mountain, a Molinia bog on clay, was profitably visited, though a struggle to reach. There was not much bryophyte quantitatively, but an interesting assortment, including Funaria obtusa, Breutelia chrysocoma, Campylium stellatum, Dicranum bonjeanii, Solenostoma crenulatum and Scapania irrigua, was noted.

11 April. We all assembled at Strumble Head in the morning, and one party moved south-westwards to work whilst another went eastwards. The sea cliffs here are predominantly west-facing and rise to 450 feet, but the coast is indented and all aspects from north to south occur. It is one of the most geologically complex coasts in Britain and this diversity is matched by a highly varied flowering plant and fern flora. Although the bryophytes were not abundant the lists obtained were quite interesting. The south-west party found Archidium alternifolium amongst cliff top turf, and Eurhynchium speciosum in a marshy patch. Further along, a small valley mire on the cliff top with Royal Fern was examined and had Scorpidium scorpioides, Riccardia pinguis and R.sinuata whilst the craggy sea cliffs nearby had small quantities of Frullania microphylla and F. fragilifolia. Weissia perssonii was noted by Rod Stern. The second party produced a list with several species not noted by the first including Grimmia stirtonii, Riccia beyrichiana and Tritomaria exsectiformis. Having re-joined we again split up about lunchtime, different car loads moving off to different places. One group went to Aber-mawr west of Granston and recorded in sessile oak woodland where Fissidens rufulus was found on wet rocks in a trickle. Further near the coast the out-flowing stream is dammed up by a storm beach backed up by a mire with willows where Cololejeunea minutissima and Orthotrichum pulchellum were noted. Another party, having just recorded at Garn-fawr fort where nothing of note grows, went on to the alder and willow mire at Aber-bach where Frullania germana was on a boulder and Plagiomnium ellipticum grew in marshy ground, but where the physiognomy and bryophytes are similar to those at Aber-mawr.

Trewellwell Wood towards St. Davids, made an SSSI on the strength of the 1958 visit, was due to be de-scheduled by the NCC, so a party recorded bryophytes there to judge whether a de-scheduling was justified. Woods are not very common in this part of Pembrokeshire, and this one is quite small. It has a stream, rock outcrops and marsh, but the bryophytes were not thought to justify its retention as an SSSI.

Dowrog Common, an extensive tract of wet heath and marsh in the upper reaches of the River Alun, is famous for its rare heath and marsh plants. Two parties visited it, a thorough search was made, and the bryophytes listed. Scleropodium tourettii grew on the public road through the centre of the Common together with Brachythecium mildeanum. Further recording was done in Merry Vale, SW of St. Davids, where Bryum donianum and Diphyscium foliosum were detected, and another party visited Abereiddy Bay, noting Pottia crinita and Cephaloziella stellulifera.

12 April. The weather remained excellent and a party of about 22 people arrived at Brynberian Moor. The wet moorland was carefully explored and some stalwarts ascended the N. slopes of the Prescellys to reach Carnalw, Carnbreseb and Carngoedog. The moorland has several streams running through it and lower down these often form flattish flushed areas. Here grow Acrocladium sarmentosum, Polytrichum alpestre, Lepidozia setacea and twelve different Sphagnum species. On the somewhat steeper slopes of the Mynydd slightly basic-flushed areas, originating from the dolerite, occur, and these gave rise to an additional list of species including Rhizomnium pseudopunctatum, Fissidens osmundoides,

Drepanocladus vernicosus and Solenostoma cordifolium. Gors-fawr, another area of wet moorland, this time on the S. slopes of the Prescellys, was next on the programme, but several carloads dissented from working here: they had had enough of bog trotting for the day, and instead made trips to other localities. The wet moorland, though very quaking in parts, was worked reasonably thoroughly and I have to thank Stephen Evans of the Nature Conservancy Council for showing it to us and guiding us safely across it and back.

Two cars went to Cwm Gwaun, a series of oakwoods clothing some 4½ miles of the steep sides of the Gwaun valley sub-glacial channel. Here, one or two nice bryophytes such as Trichocolea tomentella, Nowellia curvifolia and Jubula hutchinsiae, were turned up. Martin Corley went to examine the small bog in the narrow ice-melt-water channel between Dinas Island and the mainland and found Sphagnum squarrosum. And then he went to work the area round Abercych in the extreme NE of the county to be joined in the area by a second party who worked Penrhiw and Cnwcau. Schistidium alpicola var. rivulare was recorded in the Afon Cŷch and Scleropodium cespitans and Tortula latifolia at Abercych. Fissidens exilis was on soil from a ditch in a quarry at Cnwcau. During the day Harold Whitehouse went on a stubble field jaunt. In one near Llanbed east of Mathry he recorded Bryum microerythro-carpum, Dicranella staphylina and Ditrichum cylindricum and in another near Camrose he noted these three together with Bryum klinggraeffii and B. sauteri.

A Council meeting was held in the evening.

13 April. Minwear Wood, a deciduous woodland on the S. bank of the Eastern Cleddau, was visited by the main party. Rain had lightly fallen during the previous night, and looked like falling again very soon. The wood is mainly beech and oak, the former looking native. Orthotrichum lyellii and O. strictum were seen on the same ash and Nowellia was on several dead trunks, but the bryophytes were on the whole rather dull. As rain started to fall the party drove for drinks in the pub in Cresswell.

Afterwards, in continuing rain the sessile oak woodland on the eastern bank of the Daucleddau west of Lawrenny was reached and worked. The wood is known to date from at least 1600, and is the finest relict of the extensive oakwoods that once clothed all the shoreline of the "drowned valley" system of Milford Haven. The low stature and gnarled appearance of the oaks towards the base of the slope reflected the western aspect and moderate exposure to salt-laden winds. The epiphytes, both lichens and bryophytes, were spectacular but the latter were unfortunately not as exciting as the lichens. Lepidozia pinnata and Barbilophozia attenuata not previously seen during the week were reasonably common on rocky outcrops.

During the morning Rod Stern and his party worked the grounds of Picton Castle down to the N. bank of the Eastern Cleddau and found Tortula marginata on a concrete block and Gyroweisia tenuis on mortar in a wall. Pembroke Castle was worked by the same party who recorded Scorpiurium circinatum there.

14 April. The day started wet but undaunted we drove north out of Haverfordwest to Treffgarne Rocks, an area of Pre-cambrian rocks formed into impressive crags and tors. The area had been worked in 1958 and it was on that occasion that the Fissidens eventually described as F. celticus was first detected in Britain. Among the species noted on the present trip were Lepidozia pinnata, Bazzania trilobata and Barbilophozia attenuata. The nearby banks of the Western Cleddau and Nant-y-Coy Brook were explored and the list was augmented with species such as Plagiothecium latebricola and Porella pinnata. Fissidens monguillonii, recorded here new to Wales on the previous BBS visit, was not seen, the continuing rain probably causing this. After lunch the weather improved and we drove to Fishguard and then to Esgyrn Bottom, a raised bog with a wooded fringe in a valley left as an ice melt-water channel after the last Ice Age. Eight species of Sphagnum, Cladopodiella fluitans, Cephalozia media, Calypogeia sphagnicola, Riccardia latifrons and Lepidozia setacea were detected in the bog which, however, seemed much drier than I remembered it from a visit seven years previously. I am grateful to Mr and Mrs Jim Robinson for allowing us access. The adjoining woodland had Pohlia lutescens on a bank and Ptychomitrium polyphyllum in small quantity on boulders.

On the way back to the hotel one party looked at Ambleston Common, very wet ground with small disused claypits filled with Sphagnum. Ten different species of the latter were recorded and Jean Paton collected Pohlia camptotrachela and Lepidozia sylvatica. Another party visited Garn Turne Rocks, an archaeological site containing a burial chamber on the orthostats of which they found Andreaea rothii and Hedwigia ciliata. Eustace Jones, retracing a route he had walked in his youth, visited Solva and made a useful list from the slopes on the SE side of the harbour, including Campylopus brevipilus, Grimmia trichophylla var. subsquarrosa, Lophocolea fragrans and Marchesinia mackaii. Afterwards he listed on the southern end of Trefeidden Moor which is wet heath and marsh with some open water and found Scorpidium scorpioides in an area with slightly basic depressions.

15 April. An extensive area of limestone ridges bordered by saltings in the old quarry workings at West Williamston, and the adjoining deciduous woodland, were worked in the morning. The limestone grassland and rocks yielded a rich bryophyte flora including Bryum torquescens, Dicranella schreberana, Gymnostomum calcareum and Leiocolea turbinata.

Afterwards Lydstep Point, Carboniferous limestone sea cliffs with sea caves, was visited. This proved rather disappointing because we seemed to miss the best ground - blown sand over limestone rocks, often high above the beach. However, we saw Bryum dunense, Eurhynchium megapolitanum, Pottia bryoides and P. crinita, Scleropodium tourettii and Cephaloziella stellulifera.

Thus ended another pleasant and profitable field meeting. Including some recording done on the days of arrival and departure (not documented in the account above) twenty two 10 Km squares were visited in the county and recording cards filled in each, thereby adding greatly to our knowledge of Pembrokeshire bryophytes and helping our mapping scheme by filling in some of the gaps. Though nothing of exceptional note was found, everyone saw bryophytes,

habitats and plant communities of great interest to them. I wish to thank Stephen Evans (N.C.C.) for spending a good deal of time with me in arranging the programme for this meeting and acquiring access to some of the localities visited, and I thank all those who sent me lists of bryophytes they recorded.

A.R.PERRY

THE SUMMER MEETING, JULY 1980, DURHAM

The Summer Field Meeting was based on St Aidan's College, Durham University. It had a distinctly international flavour with participants from New Zealand and Holland as well as from various parts of Great Britain.

27 July. The party assembled at Hamsterley Forest, where the Forestry Commission Ranger, Brian Walker, acted as a useful guide. At the NW corner, there are basic rocks and flushes alongside Sharnberry Beck where Sphagnum russowii and S. squarrosum were found as well as Philonotis calcarea, Pohlia proligera, and P. camptotrachela. Among the plantations inside the Forest, there are some rocky streams and dripping rocks, where Sphagnum quinquefarium, Tetradontium brownianum and Solenostoma sphaerocarpum were seen. Also seen was Dr David Bellamy, preparing for a TV programme on his "home ground".

28 July. An unusually fine and sunny day encouraged the main party to walk the well-known "circuit" in Upper Teesdale from Sand Sike over Widdybank pastures, past Falcon Clints and Cauldron Snout and alongside the Cow Green Reservoir. Two members made full use of the special permission which had been obtained to explore Widdybank Fell itself. The bryology of the area is well-known, but the following were among the more interesting plants which were seen: Tortella densa, Catoscopium nigritum, Grimmia ovalis (= G. commutata), Rhabdoweisia fugax, Orthothecium intricatum and Schistidium trichodon; a little S. agassizii was fished out deep from the R. Tees. Much searching for dead sheep with Haplodon was done without success but there were some good patches of Splachnum sphaericum.

29 July. On another fine day, two woods lower down the R. Tees near Eggleston, well-known for their lichens but less so for bryophytes, were the object of our attention. In the morning, Great Wood produced some characteristic species of basic rocks such as Mnium marginatum, M. stellare, Taxiphyllum wissgrillii, Metzgeria pubescens and Plagiochila britannica. By the river the exposed limestone and detritus had Barbula spadicea, Porella cordaeana and Schistidium alpicola vars. alpicola and rivulare. After lunch similar habitats at the bottom of Shipley Wood were "ablaze" with yellow and orange Mimulus hybrids; the woodland had abundant ash with epiphytes including Orthotrichum stramineum and Bryum flaccidum.

30 July. The morning was free and some sought shelter from the heavy rain in the splendid cathedral. After lunch, the party travelled east to little known areas bryologically. Finchale Priory and the banks alongside the R. Wear nearby were examined as the weather cleared; liverworts were scarce in this polluted area

but mosses seen included Leptobryum pyriforme growing in a "natural" habitat, Dicranum tauricum and Fissidens crassipes. Later, a brief visit was made to a roadside exposure of Magnesian Limestone at High Moorsley, where several Barbulas were recorded including B. rigidula.

31 July. A short delay in departure was utilised in discovering 18 species in as many minutes in the garden of St Aidan's College, including Dicranella staphylina. The upper reaches of Weardale were to be explored. An old stone quarry at Westgate and a spoil heap yielded Lophozia bicrenata, Plectocolea hyalina and Scapania aspera. A pleasant walk down the Middlehope Burn added Plagiochila britannica and there was luxuriant growth of Ulota crispa var. crispa and norvegica, the only time these mosses were seen all week. Near the County boundary at Killhope, there was much excitement at finding what seemed to be Bryum weigelii, but alas it subsequently turned out to be yet another form of B. pseudo-triquetrum. On the various boulders near the burn, there were fine patches of Orthotrichum cupulatum, O. rupestre and O. anomalum.

1 August. The final day started as one of the hottest of the generally cool summer and finished with violent thunderstorms. The morning was spent at Bishop Middleham quarry among the most superb display of orchids including the Dark-red Helleborine. The Magnesian Limestone had abundant Leiocolea badensis with some Preissia quadrata. Distichium capillaceum and Gyroweisia tenuis. Later the main party found Rhizomnium pseudopunctatum at S. Hetton pond in the most easterly location visited during the week while the writer, returning south, found luxuriant Tortula subulata var. subinermis, T. latifolia and Leskea polycarpa growing at the bases of elms by the R. Tees at Croft.

Although the number of new records was not great, a pleasant week was capably organised and led by Rev. Gordon Graham, who had also arranged for the University's Botany lab. to be available in the evenings, a facility which was utilised by several participants. A total of ten 10km squares was visited and in some of them at least some useful contributions to the mapping scheme were made.

R.C. STERN

THE ANNUAL MEETING, 1980, BRISTOL

Those of us who attended the paper-reading meeting and annual general meeting at Badock Hall, University of Bristol on the weekend of September 20 - 21, were rewarded by an interesting and stimulating programme in very comfortable surroundings. It was particularly pleasing to be joined by several members, including one from overseas, who were attending their first meeting of the Society. The President and Vice-President introduced seven speakers whose topics were exceptionally diverse, a trend which was warmly welcomed and matched by the wide-ranging interests of the audience. For his skill in establishing such a programme, we are greatly indebted to Prof. J.G. Duckett. Not only were there papers devoted to field work in Britain, Bhutan and Canada, but there were others detailing fine structure of spermatozoids, carbohydrate chemotaxonomy and an analysis of bryophyte communities. Summaries of these papers are given below.

Mr. T. BLOCKEEL (Leeds): "Bryologists and Bryophytes from South Yorkshire."

Watsonian vice-county 63 (south-west Yorkshire) is the heart of industrial Yorkshire, but the composition of its flora and its recent history has much of interest for the bryologist.

Bryologists of the area have included: James and Thomas Bolton (Halifax), Jonathan Salt (Sheffield), Robert Leyland (Halifax), Samuel Gibson (Hebden Bridge), John Nowell (Todmorden), Amos Carr (Sheffield), Abraham Shackleton (Keighley), Charles P. Hobkirk (Huddersfield), Dr. Franklyn Parsons (Goole), James Needham (Hebden Bridge) and Harold Walsh (Luddendenfoot).

Floristically, the vice-county may be divided into four areas.

1. A small part of the north-western tip of the vice-county is Carboniferous limestone, consisting of low rounded hills without the natural scars and river gorges of the Dales to the North. Nevertheless, grassy banks have such species as Thuidium philibertii and the river-bank flora is better developed than in other parts of the vice-county, with Schistidium alpicola, Orthotrichum sprucei and others.

2. The millstone grit and coal measures occupy the entire western part of the vice-county. The richest habitats are in the deep wooded valleys or cloughs, of which the best example is the Hebden gorge north of Hebden Bridge. Here are one or two oceanic plants (Lepidozia cupressina, Jubula hutchinsiae) and many other species, including Andreaea crassinervia, Tetrodontium brownianum, Blindia acuta, Schistostega pennata, Isopterygium pulchellum, Mylia taylori Saccogyna viticulosa, Nowellia curvifolia and Lejeunea lamacerina. The millstone grit also has a few atypical pockets of highly calcareous material, supporting in single sites Moerckia flotowiana and Cololejeunea calcarea. Bogs are poorly developed, probably because of the effect of acid rains; consequently, the bog hepatics are sparsely distributed. Plants of open habitats include Physcomitrium sphaericum, Discelium nudum, Nardia geoscyphus and Solenostoma caespiticium.

3. A narrow strip of magnesian limestone separates the coal measures in the west from the low-level plain in the east. Desmatodon cernuus occurs on quarry waste and Lophozia perssonii on open ground and on the walls of a ruined Abbey. Open calcareous ground also has various small acrocarps including Pottia recta and Phascum curvicolle. In a few places there are wooded crags and valleys, of which the best example is Anston Stones Wood, near Rotherham. Among species known from here are : Metzgeria pubescens, Leiocolea muelleri, Scapania aspera, Marchesinia mackaii, Cololejeunea rossettiana, Distichium capillaceum, Tortula marginata and Amblystegium compactum.

4. The eastern part of the vice-county is flat and intensively cultivated. Ricciocarpus natans occurs in ponds, and there are two extensive peat bogs, Thorne Waste and Hatfield Moor. Though both of these are cut commercially for peat, some good plants remain, notably Sphagnum balticum, recently refound on Thorne Waste.

Mrs. A.G. SIDE (Rochester): "Amateur bryological work in Kent"

The speaker's amateur work in Kent began with filling in records on the 10 km. record cards of Dr. Francis Rose. Permission was given by Dr. Rose to use the cards in the production of An Atlas

of the Bryophytes found in Kent which was published in Kent in 1970 as vol. 4 of the Transactions of the Kent Field Club. Since 1971 mapping had continued but on a tetrad basis, as in the Monks Wood records centre. Such mapping had shown abundance of the species much more clearly than did the 10 km. maps though it entailed much more work.

Types of woodland to be found in Kent were illustrated and some lists of species found in these woods were given. Special emphasis was laid on Ham Street wood where Discelium nudum had been found in 1970. Pictures of Cryptothallus mirabilis, found in other woods in Kent, were shown together with more of the less common species.

Chalk downland, an important feature of the Kentish scene, had special interest for work on Seligeria paucifolia and Fissidens viridulus subspecies tenuifolius, both very common species on chalk stones in downland woods. Thuidium hystricosum and Tortella inflexa were shown as locally abundant species on the chalk.

Brief mention was made of Romney Marsh with its somewhat limited habitats, but with a capacity to produce some interesting mosses.

Work on the bryophytes of arable fields in Kent had occupied much time and patience but was inspired by the pleasure of seeing the various rhizoidal tubers to be found. A number of these tubers were illustrated to show their diversity. The results of this work had been published in Trans. Kent Field Club, volume 6 part 2, 1976.

Finally an interest in the numbers of "failed" archegonia around the bases of the sporophytes of mosses had given this amateur another subject on which to work.

Prof. J.G. DUCKETT, Dr. W.C. PANG and Dr. Z.B. CAROTHERS (Department of Plant Biology & Microbiology, Queen Mary College, London and Department of Botany, University of Illinois, Urbana, U.S.A.): "Pellia neesiana: the biggest spermatozoid in the bryophytes."

Pellia neesiana and P. epiphylla have the largest spermatozoids yet recorded for any bryophyte. The mature gametes comprise an 8.5 µm diameter helix of 3½ gyres circumscribed by a band of microtubules (the spline) of about 95 µm in overall length. Although an earlier electron microscope study by Suire suggested fundamental differences between spermatids of Pellia and other bryophytes including branching of the spline over tubular diverticula of endoplasmic reticulum and maturational disappearance of some of its microtubules, our analysis supports a quite different interpretation.

The broad anterior region of the spline (15 tubules in P. epiphylla and 13 in P. neesiana) is retained but is restricted to the first half gyre. The diverticulum in mid-stage spermatids is a tubular extension of the nucleus, devoid of chromatin which runs posteriorly for over 60 µm (2½ gyres) and is overlain by 6 or 7 long, parallel tubules.

Preliminary studies on other Metzgerialian spermatozoids (Petalophyllum, Riccardia, Symphyogyna, Fossombronia) indicate that these are all appreciably larger and more highly coiled than those of the Marchantiales (Dumortiera, Marchantia, Sphaerocarpos, Riella). The parallel orientation of the basal bodies in the Metzgeriales, a feature shared with Haplomitrium, contrasts sharply with their divergent disposition in Marchantia. As more taxa are investigated from all the major groups, but as yet lacking Treubiales and iso-

phyllous Jungermanniales, there is growing evidence that spermatozoid ultrastructure supports Schuster's phylogenetic scheme for Hepatic evolution.

When the well established criteria of evolutionary advancement from animal spermatogenesis are applied to archegoniates striking parallels emerge. Primitive animal spermatozoids have roughly spherical nuclei with prominent structures anchoring the flagella (analogous to the multilayered structure) whereas advanced taxa possess elongate nuclei and the complex anchoring apparatus is reduced or lost. In the Lycopsida, homosporous Lycopodium has 40 spline tubules and a fat pyriform nucleus whereas heterosporus Selaginella only 17 tubules and a rod-like nucleus. Similarly in the Pteropsida there is a reduction in the number of spline tubules from Osmunda (180) and Pteridium (150) to Marsilea (25) and a concomitant elongation, narrowing in maximum diameter, and degree of coiling of the nucleus from 2 and 3½ to 8 gyres respectively,

Haplomitrium (57 tubules) has by far the widest spline and broadest nucleus (coiled in about 1¼ gyres) yet encountered in the bryophytes which contrasts sharply with the much narrower splines and 3½ gyres of the rod-like nuclei in Pellia and Riccardia. Less highly coiled (2½ gyres) and slightly broader splines occur in supposedly less advanced Metzgerialian taxa such as Petalophyllum (22 tubules), Fossombronia (18) and Symphyogyna (17).

Miss A. CHRISTIE, Dr. D.H. LEWIS (Department of Botany, University of Sheffield) and Mr. A.R. PERRY (Department of Botany, National Museum of Wales, Cardiff): "Carbohydrates and chemotaxonomy in the Ptilidiaceae."

The genera, Anthelia, Blepharostoma, Herberta, Hygrobiella, Mastigophora, Pleuroclada, Ptilidium and Trichocolea were placed in the Ptilidiaceae by Evans (1939) and Jones (1958). Other taxonomists have treated these genera differently and there has been a progressive segregation of genera into several families, culminating in the schemes of Schuster (1972,1979) which recognize seven families for the eight genera.

A correlative evaluation of a range of morphological features of both gametophyte and sporophyte demonstrated that a large number of characters separated Anthelia, Hygrobiella and Pleuroclada from the other five genera. Anthelia was especially isolated.

Within the Jungermanniales, the possession of a particular combination of soluble carbohydrates is chemotaxonomically useful since patterns are consistent within species of one genus and within genera of relatively well defined families, e.g. Cephaloziaceae, Lepidoziaceae and Scapaniaceae. In addition to sucrose, the 7-carbon monosaccharide, sedoheptulose, its reduction products, α-sedoheptitol (volemitol) and β-sedoheptitol, a third uncharacterized heptitol and the 6-carbon sugar alcohol, mannitol, occur in the Ptilidiaceae (s.l.) in seven combinations. These not only emphasize the diversity of the group but also coincide with the families recognized by Schuster (Antheliaceae, Blepharostomataceae, Cephaloziaceae, Herbertaceae, Mastigophoraceae, Ptilidiaceae and Trichocoleaceae). The absence of mannitol and 7-carbon carbohydrates from Anthelia re-inforces its morphological isolation and the presence of mannitol (but absence of 7-carbon carbohydrates) in Pleuroclada and Hygrobiella supports Schuster's placing of these genera in the Cephaloziaceae.

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Dr. R.W. ALEXANDER (Department of Geography, University of Liverpool): "Some Bryophyte and Macro-lichen communities on the Pillow Lava Band Rocks of Cader Idris, Gwynedd."

This paper presented the results of a survey of the bryophyte and macro-lichen vegetation of the pillow lava outcrops on the north face of the Cader Idris range of mountains in the county of Gwynedd. The aims of the work were to sample the vegetation in an objective fashion in order to discover whether any distinct and recurring species assemblages could be identified and, if so, to examine the environmental factors controlling the distribution of such assemblages.

The major problems involved in this type of investigation are those of scale (size and distribution of rock outcrops compared to size of plants and plant communities) and the three-dimensional nature of the substrate surface. These problems could not adequately be overcome by the use of conventional methods of sample distribution and thus a new technique for the distribution of (in this case 10 x 10 cm.) quadrats was developed. This technique operated by superimposing a flexible grid onto the rock surfaces and then sampling randomly from within this grid. Application of this partial random technique gave rise to a data set of 162 quadrats containing 135 species and these data were analysed using Reciprocal Averaging ordination and a polythetic, agglomerative clustering technique. The results of both techniques indicated that the major environmental variables influencing the bryophyte and macro-lichen vegetation were base status of substrate and some measure of 'wetness' of habitat. At the four-cluster level the quadrats could be divided into 'Wet calcifuge', 'Dry intermediate to calcifuge', 'Dry calcicole' and 'Wet intermediate to calcicole' groups on the basis of certain recognised indicator species. These four major groups were further sub-divided into 14 distinct assemblages identified by constant and faithful species, and these 14 assemblages were examined in terms of their interrelationships, ecology and distribution patterns.

Work is in progress to test the validity of some of the conclusions drawn by examining the nutrient status of plants and substrates from type examples of the communities identified.

Mr. D.G. LONG (Royal Botanic Garden, Edinburgh): "Bryophyte exploration of Bhutan".

A brief historical outline of bryological exploration and study in the western Himalayas was given, from the earliest Nepalese collections of F. Buchanan-Hamilton and N. Wallich in the early 19th

century, published by W.J. Hooker and W. Harvey, followed in 1848 by the large Sikkim collections made by J.D. Hooker, these largely forming the basis for W. Mitten's "Musci Indiae Orientalis" (1859) and "Hepaticae Indiae Orientalis" (1861). The only early collector to visit Bhutan was W. Griffith, in 1838, whose bryophyte discoveries remain largely unpublished. The bryophytes of Bhutan were not studied again until a Japanese expedition visited western districts in 1967, from which a check list was published in 1971. Recent work covering some of the bryoflora includes the up-to-date E. Indian moss flora of Gangulee and monographic studies of genera such as Plagiochasma and Sphagnum. Considerable collections, most as yet unstudied, were made by the author in the forests of Bhutan in 1975 and 1979.

The main forest zones of Bhutan were described and illustrated with characteristic flowering plants and bryophytes. The jungle-clad foothills (200-1200 m) are poor in bryophyte species but with increasing altitude the forest changes to warm broad-leaved (1200-2100 m) then cool broad-leaved or evergreen oak forest (2100-3000 m) above which bryologically very rich montane coniferous cloud forest of spruce, hemlock and fir, is found up to an altitude of 3500 or 4000 m. In drier main valleys xerophytic pine forest occurs.

In the cool broad-leaved forests species such as Trachypodopsis serrulata, Meteorium buchanani, Meteoriopsis squarrosa, Herbertus dicranus, Porella campylophylla and Plagiochila chinensis are found, mostly as epiphytes on tree trunks and logs. The montane cloud forests are the richest, with a dense carpet of such species as Lyellia crispa, Actinothuidium hookeri, Ptilium crista-castrensis, Scapania ferruginea, Dicranum lorifolium. On rotten logs are found, for example, Acrobolus ciliatus, Blepharostoma trichophyllum, Lophozia incisa, Metacalypogeia alternifolia and Schiffneria hyalina, whilst common epiphytes are Chandonanthus hirtellus, Trichocolea tomentella, Diaphonodon blandus, Anastrepta orcadensis and many Herbertus, Scapania, Porella, Plagiochila and Frullania species. Aongstroemia orientalis is common on road cuttings in the forest.

In the dry pine forests Rhytidium rugosum was common and Targionia hypophylla, Trocholejeunea sandvicensis and Frullania ericoides were found on dry rocks. In moist paddy-fields the interesting pan-tropical moss Barbula inaequalifolia was often abundant. The world distribution of some of these species was illustrated, of particular interest being the group of hepatics such as Anastrepta, Anastrophyllum and Mastigophora whose origins are considered to have been in the southern hemisphere.

Dr. R.E. LONGTON (Department of Botany, University of Reading): " A British bryologist in Canada."

Canada is a vast country and it is sparsely populated except in the extreme south. It thus contains several million sq. km. of virtually undisturbed natural vegetation, principally coniferous forest and tundra, occurring at a wide range of elevation and climate. There are few bryologists: the second edition of "Directory of Bryologists (I.A.B.1979) includes only 20 Canadian entries, and of these perhaps 9 can be regarded as established research workers. In contrast to Great Britain there is no strong tradition of co-operation between amateurs and professionals. Thus, despite the vigorous efforts of a handful of bryologists past and present, Canada offers tremendous scope for bryological research across the whole spectrum from basic floristics to the most sophisticated modern studies.

Some of this potential was illustrated by an illustrated account of vegetation in the Province of Manitoba. Among the points noted were the poor state of knowledge of the bryophyte flora of the Province, from which no species of such ubiquitous genera as Cephalozia and Cephaloziella had until recently been recorded, the strong circumpolar element in the boreal bryophyte flora, the high frequency of sporophyte production of Pleurozium schreberi throughout the forest region, the extensive destruction of P. schreberi and other mosses by pollutants from isolated industrial operations, and the use of dried Sphagnum in baby-care by indigenous Canadians.

After the annual general meeting (Minutes in Bulletin 38), members were welcomed by Prof. B.K. Follett, who had kindly arranged an enjoyable University reception on our behalf. The meeting continued in the evening with a conversazione which provided an opportunity to examine a large number of exhibits, as indicated by the following list.

Dr. K.J. Adams : Some recent library accessions.

Dr. D.H. Brown : Bryophytes from the Broome Herbarium Bath.

Mr. A.C. Crundwell : Reproduction in Myurium hochstetteri.

Mr. M.V. Fletcher : Some cultivated Eurhynchiums.

Dr. E.W. Jones : Some hepatics of the "Mist Forest" of tropical African mountains.

Mr. D.G. Long : General literature relating to Bhutan.
Bryophyte specimens collected in Bhutan, East Himalaya in 1979.
Literature relating to east Himalayan bryophytes.
Barbula inaequalifolia Taylor.

Mr. A.R. Perry : Leaves from the B.B.S. Photo album.

Logo.

Dr. C.D. Preston & Dr. H.L.K. Whitehouse : Conservation of Eurhynchium pulchellum on Lakenheath Warren, Suffolk.

Mrs. A.G. Side : Note books. Bryological work in Kent.
a) some new Vice County Records since 1970.
b) state of the tetrads.
c) mosses not seen by A.G.S. since 1970.

Dr. H.L.K. Whitehouse : Agar cultures of some tuber bearing mosses.

The Sunday excursion was blessed with fine weather, a matter for thanksgiving in such a poor season.

In the morning Ebbor Gorge was visited. This is a well-worked site on the Carboniferous Limestone, now a National Trust Nature Reserve. Most of the more interesting calcicoles known from the Reserve were seen. These included Cololejeunea rosettiana, Marchesinia mackaii, Metzgeria conjugata, Isothecium striatulum, Grimmia orbicularis, Bryum canariense and Tortella nitida. Alan Crundwell spotted Zygodon baumgartneri on an ash tree and Jean Paton added Fossombronia pusilla and Dicranella rufescens to the list. Some people sought for Plagiochila britannica among the rich welter of bryophytes but without success. Several members

were pleased to see Rhynchostegiella teesdalei in the small stream at the bottom of the Gorge.

After a climb through somewhat undistinguished woodland the party emerged rather dazedly onto the plateau above the Ebbor Rocks. Nothing of particular interest was found but it was generally felt that the magnificent view amply compensated for the lack of bryological entertainment.

Lunch was eaten in warm sunshine on the grassy verge of the car park. After this pleasant al fresco interlude a move was made to the vicinity of the area known locally as Priddy Pools, on the Old Red Sandstone. Soon after leaving the cars the attention of several of the party was attracted by a small moss growing on firmly compacted soil in company with Dicranella varia, Ceratodon purpureus and Barbula convoluta. It has since been found with fruit and appears to be closely related to Dicranella varia but has not been named. Leptodontium flexifolium was sought and found on a Calluna covered slope in its only known station in North Somerset. There was not time to visit the pools nor to go as far as the old lead mine about half a mile away but a small heap of lead mine waste was found on which Racomitrium lanuginosum and Grimmia donniana were seen. David Long was especially pleased to find Equisetum prothalli, of particular interest to Jeff Duckett who unfortunately was not present. Dr. Dennis Brown then took us over the road into a Forestry Commission plantation to demonstrate an area where the concentration of lead is so high† that no trees can be persuaded to grow. The conditions are exactly those rejoiced in by *Ditrichum plumbicola which was found on this otherwise almost barren patch of soil.

I would like to thank those members who sent me lists of species seen during the day.

† 31,000 to 51,000 ppm dry wt. of soil for Pb; 500 to 550 ppm for Zn.

* Vice county record.

J. APPLEYARD.

Coupled with the Sunday field excursion, kindly summarized by Mrs. J. Appleyard, this was a successful and rewarding meeting. It could not have been so without the efforts of Dr. D.H. Brown and Mrs. Appleyard, who organized the indoor and outdoor activities respectively, and the Society must be very grateful to both.

M.E. NEWTON.

TAXONOMIC WORKSHOP, 1980

This meeting was held over the weekend of 1 and 2 November, based at the Department of Botany, University of Reading by kind permission of Professor V.H. Heywood. About 30 members and guests attended.

Saturday was spent on the chalk of south Oxfordshire. In the morning we visited the Warburg Reserve at Bix Bottom, owned by the Berkshire, Buckinghamshire and Oxfordshire Naturalists' Trust

and named in honour of the late Dr E. F. Warburg. No rare bryophytes were recorded, but a good range of woodland and chalk grassland species was seen, including Brachythecium salebrosum, Bryum flaccidum, B. ruderale, Entodon concinnus, Orthotrichum affine, Pottia recta, Ulota crispa and Zygodon conoideus. The keen eye of Mr R. J. Fisk detected a single plant of Ephemerum recurvifolium! In the afternoon chalk grassland on the north side of Watlington Hill yielded, among others, Mnium stellare, Neckera crispa (c.spor.), Thuidium abietinum ssp. hystricosum and Tortella tortuosa.

Saturday evening and Sunday were spent in and around the Botany Department working over specimens and enjoying talks and demonstrations on the themes "Identification of Bryum and Pohlia", and "Cultivation of Bryophytes". Dr E. V. Watson gave a talk entitled "Problems of a Referee in the Bryaceae" as well as displaying slides depicting leaf and peristome characters of member species. Demonstrations of bryophytes in agar culture were presented by Drs H.L.K. Whitehouse and R.E. Longton, and the greenhouse culture collections of Mr M.V. Fletcher and the University of Reading were examined. Thanks are due to Mr Fletcher, Dr Watson and Dr Whitehouse for their contributions to what appeared to be an enjoyable and instructive meeting.

R. E. LONGTON

GRANTS FOR BRYOLOGICAL PROJECTS

The Council of the B.B.S. is establishing a small fund to encourage worthwhile bryological projects that would otherwise be unlikely to attract financial assistance, and has set up a Grants Committee to consider applications. These may be made at any time and should include a detailed conspectus and realistic financial budget. They will be judged on their individual merits.

Examples of the kind of project Council has in mind for support fall into two categories: (A) those involving individuals, e.g. travelling expenses for recording in underworked areas to help meet the mapping scheme deadline; assistance in defraying publication costs or expenses involved in the preparation of a publication such as a regional Flora; or expenses incurred in the detailed assessment of rich bryological sites, or the habitats of endangered species, in order to promote their conservation. Council is, however, very keen to encourage projects in the second category: (B) that will involve a substantial number of members and encourage our amateur and junior members to participate. Examples are: a national survey of the distribution of a small group of critical species. The proposer of such a project would design a questionnaire card giving exact details required of the observer, and would be expected to examine a large number of specimens, as in the highly successful B.S.B.I. critical species and network projects. Other possible projects might be: a survey of the occurrence or timing of sporophyte production; the distribution of male and female gametophytes of particular species; the biometry of polymorphic taxa; the size and vigour of pollution-vulnerable species; etc.

The questionnaire would be distributed free with the Bulletin and the proposer would be expected to submit results for publication in the Bulletin or Journal within a reasonable period so that members are encouraged to participate in future projects. It should be noted that these small grants are not intended to supplement projects that are already receiving support from a University or Polytechnic research school.

Applications should be sent to Dr K.J. Adams, Chairman B.B.S. Grants Committee, Dept of Biology, North East London Polytechnic, Romford Road, London E15 4LZ.

FUTURE MEETINGS OF THE SOCIETY

SPRING FIELD MEETING, 1981, 8 - 15 April.

Organisers : Professor J.G. Duckett & Dr. K.J. Adams.

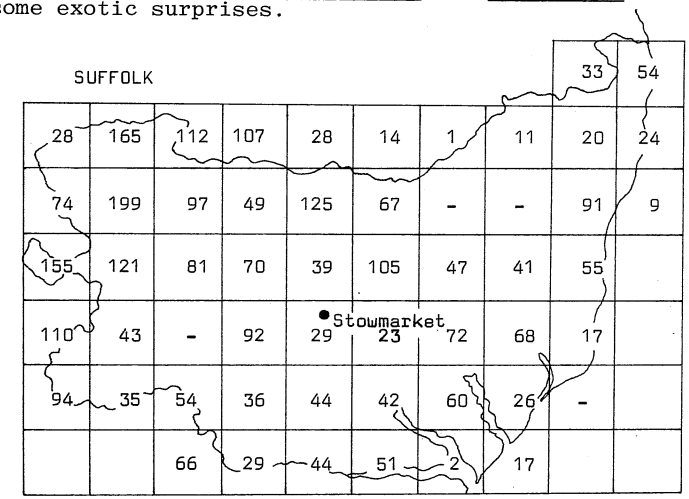
Local Secretary : Dr. K.J. Adams, 63 Wroths Path, Baldwins Hill, Loughton, Essex. IG10 1SH. tel: 01 508 7863.

Headquarters : The Cedars Hotel and Restaurant, Needham Road, Stowmarket (tel: Stowmarket (04492) 2668). Non-residents can use the restaurant and conference room. Nine twin-bedded rooms have been reserved. B. & B. £9.50 per person.

Provisional bookings have been made at nearby guest houses for 4 people B & B at £5.00 and for 6 people B & B at £7.00. Plenty of good accommodation is also available at the Fox Inn, Ipswich Road, at £10.00 for B & B. These are all current prices and may increase slightly by April. All bookings should be made through the local secretary.

It is hoped to arrange laboratory facilities at a nearby school for at least two evenings so that material can be examined microscopically, and several members have volunteered to be on hand to help beginners who will be especially welcome at this meeting. Microscopes and slides etc., can be provided if booked well in advance.

PROGRAMME: The field excursion programme is being arranged in association with the Suffolk Naturalists' Trust and the Nature Conservancy Council. Localities to be visited include the Breckland heaths of the north-west of the county (Rhytidium rugosum, Pleurochaete squarrosa, Eurhynchium pulchellum, Dicranum polysetum); fen areas such as Redgrave and Lopham Fens (Moerckia flotoviana, Pressia quadrata, Riccardia latifrons); and a special 'field day' will be devoted to Notcutts Nurseries, Woodbridge, where the enormous acreage of cultivated plots should yield arable field species such as Sphaerocarpos michelii and S. texanus - and hopefully some exotic surprises.



Situation map. 10 km sq totals 1980.

With the closing date for the Bryophyte Atlas scheduled for late 1982 it is important that we use this meeting to good advantage. Accordingly visits to sites of particular interest will be organised for the mornings and members will be encouraged to 'bash' some of the underworked 10 km squares in the afternoons.

Intending participants should write to or telephone the local secretary for booking forms and further details as soon as possible.

SUMMER FIELD MEETING, 1981

Newtonmore, Inverness-shire and Crianlarich, Perthshire, 21 July - 4 August.

Newtonmore 21-28 July 1981

Local Secretary : David Long, Royal Botanic Garden, Edinburgh, EH3 5LR. tel: 031 552 7171

Headquarters : Macdonald Lodge Hotel, Newtonmore, Inverness-shire (tel: 05403 256)
(Dinner, bed & breakfast £14 at 1980 prices)

Transport : 8 trains per day from Edinburgh/Glasgow.

Accommodation : a wide range of hotels, bed and breakfast, caravans, camping, etc. is available. More details available from local secretary. Early booking advised.

Maps : O.S. 1:25000 sheets 35,36,42.

Newtonmore lies in the upper Spey valley west of the great massif of the Cairngorm Mountains, a district famous for its wildlife, especially the native pine forest, rare plants and birds. The Cairngorms, although composed of acidic granite, support a rich bryophyte flora of an Arctic-Alpine nature, mostly in the big corries and late-snow beds. Characteristic species include Andreaea nivalis, Polytrichum norvegicum, Dicranum spp. e.g., D. glaciale, Chandonanthus setiformis, Gymnomitrion and Marsupella spp. and Pleuroclada albescens. To the north of the Spey lie the bryologically little-known Monadhliath Mountains, to the south-west the Ben Alder Forest, the latter much more diverse geologically with outcrops of high-level limestone and many rare bryophytes, not to mention the stronghold in Britain of Phyllodoce caerulea. The Spey valley itself provides a diversity of lowland habitats, some very interesting for bryophytes as well as being a home for Ospreys. A striking and not uncommon plant in the pine forests is Ptilium crista-castrensis; the abundance of epiphytic mosses and lichens is also conspicuous; Orthotrichum striatum and O. speciosum are reputedly not uncommon.

The aims of the excursions will be to give members from distant places an opportunity to see some of the characteristic communities of the district, covering as wide a range of habitats as possible but concentrating on the mountain flora and secondly to cover some lesser-known areas as a contribution to the mapping scheme. A number of low-ground excursions will be planned; in addition, for those participants not wishing to join all the mountain excursions, and in case of inclement weather, less-strenuous low-ground alternatives will be suggested. For a good account of the rarer bryophytes of the district see Trans. B.B.S. 3 (2) : 342-345, 1957. A more detailed programme of excursions will be prepared by the local secretary before the meeting.

Crianlarich 28 July - 4 August 1981

Local Secretary : Dr. P. Pitkin, Nature Conservancy Council,
12 Hope Terrace, Edinburgh EH9 2AS.
tel: 031 447 4784

Headquarters : Crianlarich Hotel, Crianlarich, Perthshire FK20 8RW.
(tel: Crianlarich 272.)
(Dinner, bed & breakfast £12 single at 1980 prices)

Transport : 3 trains per day from Glasgow, except Sunday, 2 buses per day from Glasgow, 1 bus per day from Edinburgh. Public transport from Newtonmore to Crianlarich is very difficult; hopefully sufficient private car space will be available.

Accommodation : The HQ is the only hotel in Crianlarich, early booking is essential; there are a number of good guest houses in the village. The nearest alternative hotel is in Tyndrum, a less-attractive village 5 miles away but with some good bryophytes very close at hand. More details from local secretary.

Maps : O.S. 1:25000 sheets 50,51,56.

Crianlarich is a convenient centre from which to gain access to potentially some of the richest Scottish mountains bryologically - the western end of the Breadalbane and Glen Lochay mountains, and others farther west such as Ben Lui and Ben Vorlich. These mountains are built of metamorphic rocks, predominantly schists among them the famous base-rich mica schist of Ben Lawers as well as metamorphosed limestone which outcrops in many places. In conjunction with the comparatively high rainfall due to its more western situation, this gives the district a very diverse bryoflora. Rare alpine phanerogams such as Bartsia alpina are locally common, and a good number of the rarer bryophytes from the Ben Lawers district occur or could reasonably be found on some mountains. Typical alpine basicoles are Anoectangium warburgii, Orthothecium rufescens, Oncophorus wahlenbergii, Timmia norvegica, Scapania degenii and Tritomaria polita. The high rainfall provides the added bonus on Ben Lui and other hills of a fine range of oceanic-montane hepatics - Herbertus aduncus, Pleurozia purpurea, Scapania ornithopodioides, Plagiochila carringtonii and Mastigophora woodsii. In the lowlands plenty likely spots occur for instance the only Scottish locality of Ditrichum plumbicola is close at hand. In the Loch Lomond area the keen-eyed should find in some of the wooded ravines a very fine selection of oceanic liverworts such as Metzgeria hamata, Mylia cuneifolia and many members of the Lejeuneaceae. A special effort will be made during the week to find Bryoerythrophyllum (Barbula) jamesonii, a very rare plant recently detected in Britain amongst old collections from several mountains in the area. As on the Newtonmore week, a flexible programme will be drawn up to allow for bad weather conditions and for less-energetic participants. For further details please contact the local secretary.

ANNUAL GENERAL MEETING AND PAPER READING MEETING, 1981

Single study bedroom accommodation has been reserved at Lancaster University for the weekend of Sept. 19th to 20th 1981. Further details will be provided in the next Bulletin but, since early booking would be appreciated at a time when many of us will be away on holiday, it would help our local secretary, Dr. A.J.C. Malloch (Department of Biological Science, University of Lancaster, Lancaster, LA1 4YQ) if as many people as possible sought booking forms well in advance. Costs will be itemized as usual but as an indication, it is expected that the entire weekend including Friday dinner and packed lunch on Sunday will be in the region of £28 to £29.

TAXONOMIC WORKSHOP, 1981.

This will be held at Thames Polytechnic on the weekend of Nov.28th to 29th, 1981. Dr. P.D. Coker (School of Biological Sciences, Thames Polytechnic, Wellington St., London, SE18 6PF) has agreed to act as local secretary and is planning a field meeting to woodlands in S. Essex and E. Hertfordshire on the Sunday. Further details of this and of the subjects to be covered will be in the next Bulletin.

OTHER BRYOLOGICAL MEETINGS, 1981

4-8 April: Mosses and Liverworts. Dr Kery Dalby. The Drapers' Field Centre, Rhyd-y-Creuau, Betws-y-Coed, Gwynedd, LL24 OHB

29 July - 5 August: The Identification and Ecology of Lower Plants. Dr Allan Pentecost. Malham Tarn Field Centre, Settle, Yorkshire, BD24 9PU.

29 July - 6 August: Moss and Liverwort Identification Course. Epping Forest. Tutor: Ken Adams (BBS Librarian). Write for details to :- Dr R.G. Smith, Biology Teacher's Centre, North East London Polytechnic, Romford Road, London. E15 4LZ.

11 - 18 September: Mosses and Liverworts. Dr Martha Newton. Preston Montford Field Centre, Montford Bridge, Shrewsbury, SY4 1DX.

23 - 30 September: Bryophytes. Brian Brookes. Kindrogan Field Centre, Enochdhu, Blairgowrie, Perthshire, PH10 7PG.
The course at Kindrogan is run by our member Brian Brookes who is the Warden. This course is particularly suitable for beginners. He welcomes individual adults and small groups at Kindrogan, either to participate in advertised courses or on an assisted basis. The fee for the bryophyte course is £75 which is inclusive of board, accommodation and all academic facilities. He would be pleased to provide copies of the full programme and further details of any 1981 courses on request.

B.B.S. MAPPING SCHEME, 1980

There has been a steady flow of British records during 1980, mainly from under-worked squares. The situation in Britain and Ireland - after 20 years of recording - is as follows (data for 1979 in brackets):

Well-worked squares	Under-worked squares	Unworked	Total
		GT.BRITAIN	
1162	1057	414	2633
(1101)	(1041)	(491)	
		IRELAND	
72	329	546	947
(72)	(329)	(546)	

Information on under-worked areas is given in Bulletin 35.

As there are only two years left for recording for the proposed atlas it would be helpful if members would let me have any record cards to which they are unlikely to add further records.

Although the final date for records for the proposed bryophyte atlas is December 1982 it is not intended that recording should cease then. With only 44% of British and 7% of Irish 10km grid squares well worked it is intended to continue accumulating records for a possible second edition of the atlas some time in the future.

Record cards are available from me at 50p for 10 including postage.

A.J.E. SMITH

NERVE WIDTH IN PHILONOTIS SPECIES

It has been drawn to my attention that nerve widths in Philonotis fontana, P. seriata and P. calcarea are incorrect in The Moss Flora of Britain and Ireland. On checking I found that I had multiplied micrometer eyepiece readings by the wrong factor when preparing the descriptions - the readings had been multiplied by 2 instead of 0.8. This means that the stated nerve widths should be multiplied by 0.4 to give correct widths as follows:

P.fontana	-	64-128(-160) µm
P.seriata	-	96-192 µm
P.calcarea	-	(80-)128-240 µm

Corresponding corrections should be made at dichotomy 6 of the key on p.459.

A.J.E. SMITH

LIBRARY SALES AND SERVICE 1981

Members wishing to borrow papers or books from the Library should indicate when a xerox copy of the appropriate pages would do instead of the original. This saves enormously on postage. The current cost of xerox copies is 5p per exposure. It should be noted that the Librarian is under no obligation to supply xerox copies but is willing to do so while xeroxing facilities are available.

Members wishing to consult items in the Library in person are asked to contact the Librarian (tel: 01 508 7863), at least 3 days in advance. The nearest underground station is Loughton on the Central Line.

FOR LOAN:

(a) Approximately 200 bryological books, bryological journals and several thousand offprints of individual papers. Catalogue to the books and journals available from the Librarian, price 50p.

(b) Transparency collection, list available (S.A.E.). 624 slides in the collection. Loan charge 50p plus return postage. Only 50 slides may be borrowed at once to minimise possible loss and damage.

FOR SALE:

British Bryological Society Bulletins: Back numbers from No. 23 @ 60p each.

Transactions of the British Bryological Society:

Vol. 1 parts 1-5 (£1.60 each)
Vol. 2 parts 1-4 (£3.00 each)
Vol. 3 parts 1-5 (£3.00 each)
Vol. 4 part 1 (£3.00), part 2 (£1.50), parts 3-5 (£2.00 each)
Vol. 5 part 1 (£2.00), parts 2-4 (£3.00 each)
Vol. 6 part 1 (£3.00), part 2 (£4.00)

Volume 6 part 2 completes the series of Transactions. Volume 7 part 1 continues the series but is renamed Journal of Bryology.

Vol. 7 parts 1-4 (£2.50 each)
Vol. 8 parts 1 & 2 (£3.00 each), part 3 (£3.50), part 4 (£5.00)
Vol. 9 parts 1 & 2 (£4.50 each), parts 3 & 4 (£6.00 each)
Vol. 10 parts 1 & 2 (£7.00 each), parts 3 & 4 (£8.00 each)
Vol. 11 part 1 (£8.00)

Census Catalogues:

Duncan, J. B.	Census Catalogue of British Mosses, 2nd edition 1926	(13p)
Sherrin, W. R.	Census Catalogue of British Sphagna. 1946	(5p)
Paton, J. A.	Census Catalogue of British Hepatics, 4th edit. 1965	
	Remaining stock at half price: plain 19p, interleaved 22p.	
Warburg, E. F.	Census Catalogue of Britsh Mosses, 3rd edition 1963	
	Remaining stock at half price: plain (only) 19p.	

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POSTAGE & PACKING EXTRA. Please do not include cash with U.K. orders.

Customers will be invoiced for the correct amount including P & P with goods to minimise correspondence.

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All the above items are available from the B.B.S. Librarian:

Dr Kenneth J. Adams, 63 Wroths Path, Baldwins Hill, Loughton, Essex IG10 1SH

MICROSCOPE TECHNIQUES I

by K. J. Adams

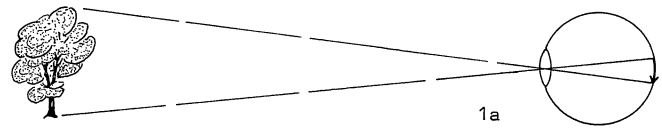
Although many of our members gain familiarity with microscopes through a professional training in biology, to the amateur working in isolation such an instrument can appear beyond financial reach, or if possessed may constitute a source of bewilderment and frustration. This article is intended to enable someone with little previous knowledge of optics to both choose and operate a compound microscope specifically for the examination of moss and liverwort material, together with some tips on the use of a handlens.

This is very much an experimental first attempt. Please criticise and help to improve it so that a final version can be produced as a standard pamphlet for beginners. Techniques for preparing and examining bryophyte material will be covered in Part II.

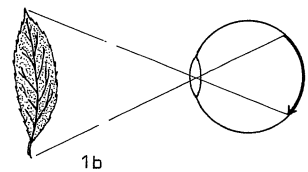
1. INTRODUCTION:

To use a lens or microscope effectively it is important to appreciate the concept of resolution. When for example, we look at a distant tree, and the lens of the eye focusses an image of the tree onto the millions of photoreceptor cells that form the retina at the back of the eye (Fig 1a) there is a limit to the detail that the retina can resolve, this being reached when individual details (say leaves) are too close together to fall on separate receptor cells. Just as in a photographic print, no detail finer than the grain of the emulsion can be resolved.

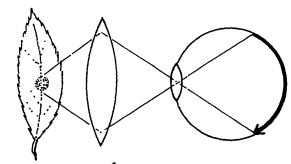
To resolve more detail the eye can be moved very close to the tree, so that the image of say a single leaf can be spread right across the retina, instead of that of the whole tree, and the shape of the leaf and even the veins can be resolved because the image of the leaf now covers thousands of receptors (1b).



1a



1b



1c

To get close enough for the image of just a few cells from our leaf to be spread over the same area of the retina, so that individual cells and even their contents can be resolved is prevented however by the inability of our eyes to focus an object much closer than about 20cm. Fortunately, lenses can be used to deflect the light rays and converge them onto the lens of the eye to simulate a closer look (Fig 1c). For the cells to be resolved by the retina however the lens must not distort the image unduly, or despite looking 'bigger' i.e. being magnified, the detail will be blurred. A good lens does more than just magnify the image, it increases the resolution of detail. To design such a lens for high resolution work is a formidable mathematical problem that can only be solved for a given set of conditions, in which for example the direction of illumination and the refractive index of the light path components are closely controlled. This is what microscopy is all about.

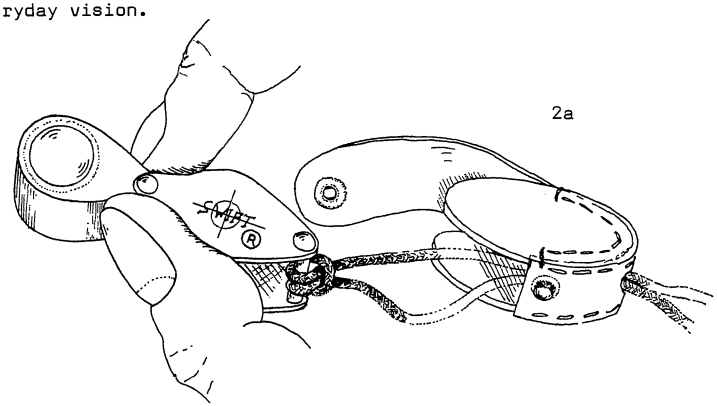
Deviation from this rigid set of conditions for a given lens system results (if at all) in a variety of possible false images that can mislead the unwary. To quote, - 'if the user is doing something he does not appreciate ... the laws of optics are quite impartial and always answer a fool according to his folly'. It is the intention of this article to minimise such follies.

2. CHOOSING A HAND-LENS:

Most budding bryologists graduate to a compound microscope after first using a hand-lens. Even to get the best out of a hand-lens however the user must be open minded enough to take advice on how to use it to best advantage. For the serious bryologist a X8 or X10 lens is frustratingly inadequate, - leaf nerves, thickened borders, serrated margins and all but the largest cells are tantalisingly just beyond resolution. Unfortunately many users of a X20 lens are no better off because they either hold it too far away from the eye, fail to arrange for adequate illumination or do not hold the lens rigidly enough to minimise marring of the image due to vibration, and for one reason or another fail to get the maximum resolution from their lens.

Even higher magnification lenses are on the market, but these suffer from a number of drawbacks and need considerable skill and patience to be used in the field. A multi-element X50 lens for example takes in light from such a tiny area that it needs to be mounted in a barrel with a battery operated light source and the depth of field ('thickness of the specimen in focus') is so shallow that it is virtually impossible to hold it steadily in focus. Such lenses are virtually hand-held compound microscopes and are not that useful to the field bryologist. A X20 lens provides a good compromise in the field.

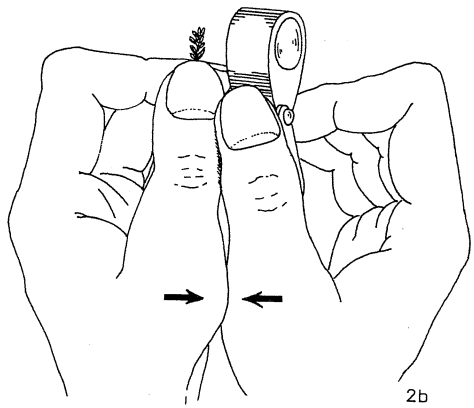
Although X20 lenses come in a variety of sizes and frames, one with a tiny aperture can be restrictive, making it difficult to locate parts of an object and the slightest movement can cause the frame to break across the line of sight. The Japanese Swift achromatic is the best X20 lens I have come across. It has a wide (12mm) aperture, and is mounted in a solid stainless steel frame that is tapered so that it can be gripped rigidly between the thumb and forefinger, and it does not come unscrewed and 'fall-apart' as many multi-element hand lenses do, resulting in dirt and dust between the lens elements (Fig 2a). Although many will argue that there is no point in having a wide aperture X20 lens because only the centre of the field can be brought into sharp focus. Nevertheless a wide aperture has its advantages, not least the fact that the eye can gain a considerable amount of information from the fuzzy peripheral field, making it easier to locate areas of an object that 'look good' with the unaided eye, and very often the overall shape of a shoot or the arrangement of a group of leaves can be adequately resolved. The eye after all is quite adept at gaining information from a fuzzy peripheral field in everyday vision.



2a

Many bryologists prefer to have an initial look at their quarry under a X8 or X10 lens and then home in on detail with a X15 or X20. Hand lens packages are available with lenses that swing out in all directions like a camping knife. Apart from being rather fiddly to use in the field, changing from one lens to another frequently results in failure to refind the 'good bit' under a higher magnification. A lower power lens does however give the advantage of enabling one to see larger sectors of a specimen in sharp focus. It is particularly helpful for those who become long sighted and can no longer resolve with the naked eye the gross 'pattern' of a moss or liverwort that enables the experienced bryologist to identify a plant in a way that is impossible to describe in words, and is seldom rendered adequately on a photograph.

To use a X20 lens, hold the lens-mount rigidly between the thumb and forefinger, locking them against the cover/handle (2a), and bring the elbow up against the chest for support; then grip the specimen between the apices of the thumb and forefinger of the other hand and hold it in front of the lens, locking the two fists in close contact (2b) to give a rigid vibration free frame and to be able to hold the object a constant distance from the lens, a critical aspect at such high magnification and hence shallow depth of field. Now bring the combined fists close to the right eye, the surface of the lens almost brushing against the eyelashes, the fist holding the lens resting against the cheek bone, and both elbows resting firmly on the chest. To achieve maximum resolution and the widest angle view of the specimen it is essential to bring the eye as close as possible to the lens so that the image covers as large an area of the retina as possible.



2b

Having achieved a rigid optical frame with the specimen, the lens, and the eye all firmly held in line, it is necessary to ensure optimum illumination. For resolving the surface texture of a bryophyte, light should be reflected from the surface and transmitted light should be minimised or it will swamp the information imparted on the reflected rays. On the other hand transmitted light will enable you to see leaf outlines and cell shape in more detail. To use the maximum resolving power of the lens tease a fragment from the edge of a tuft, ideally a single stem, so that it projects and can be viewed against the light. The silhouette will help you to see the shape and arrangement of leaves while light passing through the specimen from behind should resolve nerves and even cell outlines. To obtain maximum illumination, throw your head back and turn towards the light so that the specimen is seen against the brightest part of the sky. Take care in interpreting what you see. If the light is scattered and comes from all directions as on an overcast day, the resolution will be good, if however you look up at the sun on a bright day the unidirectional nature of the light will permit shadows to form and edges to diffract. An electric light bulb will cause the same problems if viewed directly. The specimen should be held 5mm in front of the lens to focus it.

Try comparing a fresh strand of Fissidens bryoides with that of F. taxifolius. With optimum illumination a X20 will just resolve the border on a leaf of the former, but will fail to resolve the minute serrations of the latter.

Nevertheless in a unidirectional light field the serrated edge of F. taxifolius can cast minute shadows and the edge can diffract the light so that the leaf appears to have a border. This 'border' will come and go as you rotate it in the light field. Such ambiguities can only be avoided with experience. If in any doubt take the specimen home and examine it under the compound microscope.

3. THE COMPOUND MICROSCOPE:

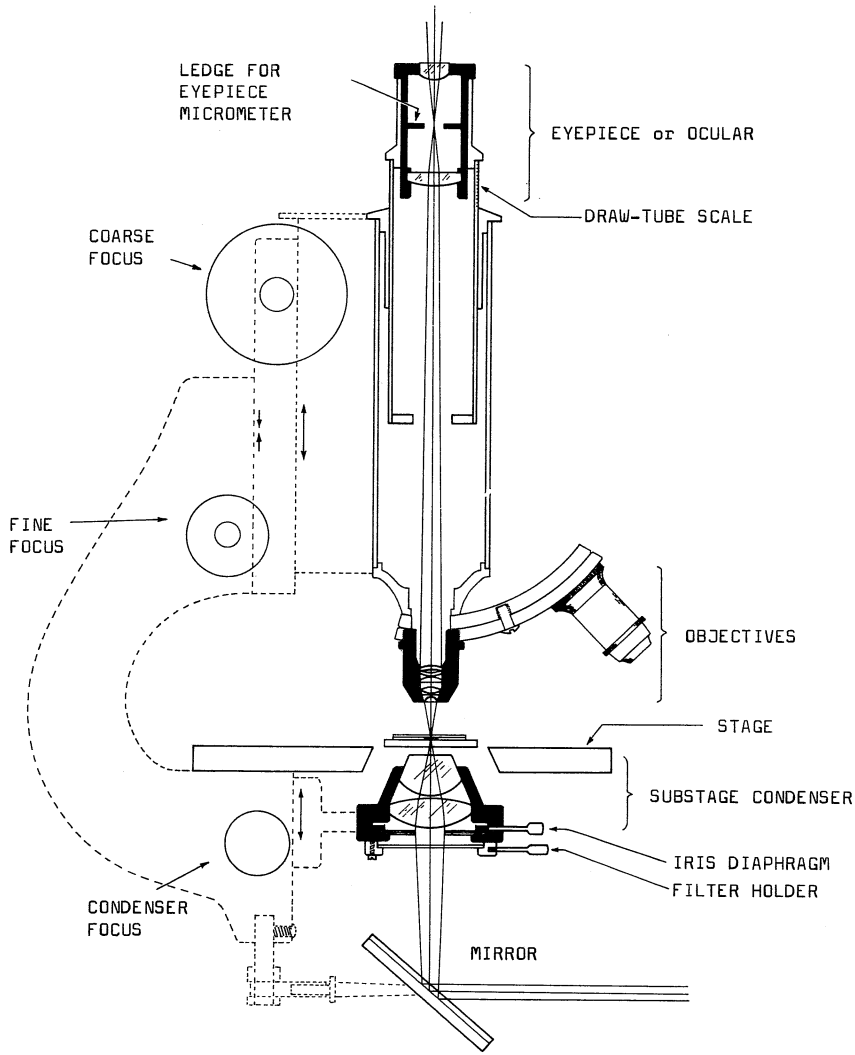
There are many different makes of compound microscope, both new and second-hand on the market. On the assumption that anyone buying a new model will have an instruction booklet, this article is primarily aimed at the not-so-rich amateur who has purchased or is about to buy what for him will have to serve as an 'all purpose' monocular microscope. The possibility of ever acquiring an accessory dissecting microscope or a binocular zoom model being a distant dream to be associated only with a pools win.

As we have seen with the X20 hand-lens, the main problems associated with examining a specimen at high magnification are to hold it rigidly in relation to the lens so that it can be maintained in focus at a fixed distance, and at the same time be adequately illuminated. A further requirement arising from the shallow depth of field is the ability to move the lens system up and down in a slow controlled, precision movement to allow an appreciation of detail throughout the depth of the specimen. In addition some means of keeping the specimen perpendicular to the optical axis is required so that it can be moved laterally in the focal plane to observe its various parts.

These exacting requirements are met in the compound microscope by mounting the optical system on a heavy metal frame, the LIMB, above and below a thick rigid plate, the STAGE, that is fixed at right angles to the optical axis (Fig 3a), and on which the specimen can be moved in the two dimensions of the focal plane. Below the stage is the SUBSTAGE, a unit usually consisting of a CONDENSER LENS system, an IRIS DIAPHRAGM and a FILTER HOLDER, mounted in some way so that it can be moved up and down along the optical axis. As can be seen in 3a this vertical movement permits the focussing of the light rays onto the specimen on the stage.

Below the substage a source of illumination is required. For the amateur a microscope with a built-in light source can be a real headache. They usually require special bulbs which are always difficult to obtain, are expensive, and come in such a variety that any one type is seldom on the market for any length of time, and should the lamp housing become misaligned can give no end of trouble. The safest, cheapest and most reliable lighting system for the amateur is undoubtedly the simple gimbol-mounted substage mirror, in combination with a suitable electric lamp. Choose ideally, an opal, mushroom bulb to provide an even field without the filament showing. 40 watts is more than adequate, a heavier bulb will only overheat, dramatically reducing its life, apart from burning your hand every time you attempt to adjust it. Nowadays such a variety of small adjustable and hooded table lamps are on the market that it hardly seems necessary to invest in a special microscope lamp.

If you are buying a second-hand microscope with a sub-stage mirror be sure to check that the silvering is intact. Most MIRRORS simply fit into a stirrup-shaped gimbol mount that is springy and holds the mirror on two pips, this in turn being mounted on a short shaft that slides into a split tube attached to the limb of the microscope. If the mirror is loose and swings around at the slightest touch, spring open the stirrup and remove it. Then squeeze the two ends together slightly and replace the mirror, which should now stay put in any position required. Similarly if the short shaft is a sloppy fit, remove it and carefully squeeze the split tube until it grips the shaft firmly. Traditionally, sub-stage mirrors have two mirrors mounted



3a FUNCTIONAL COMPONENTS OF A TYPICAL STUDENT'S MICROSCOPE

back to back, one flat the other concave. Always use the flat side of the mirror as this is the only reflecting surface that can provide a pencil beam with all the rays coming to a focus in the specimen plane. Whatever angle the concave mirror is adjusted to, the beam produced is uneven and astigmatic, and unsuitable for critical work. The original idea of the concave mirror was to concentrate light from a weak source when no other was to hand. Now that electric lighting is universally available however the concave side of the mirror is an anachronism, and should never be used in combination with a sub-stage condenser.

The main concern of the would-be purchaser of a second-hand microscope should be to ensure that the optics are satisfactory. These are grouped into three sytems. The SUB-STAGE CONDENSER, already mentioned, consists of a multi-element block of lenses that can be moved up and down beneath the stage to focus the light beam onto the plane of the specimen. The movement may be accomplished by a rack and pinion or a less satisfactory spiral track mechanism. In either case a knurled-knob will be found beneath the stage for making this adjustment. The cheaper microscopes have the sub-stage condenser mounted in a precentred, fixed mounting clamp, so that no centreing adjustment is necessary. This is fine providing nobody has in the past bashed or dropped the microscope and distorted the clamp. If the iris diaphragm is an integral part of the substage unit, as it usually is in this type of microscope, check the centreing by closing down the iris as far as it will go and focussing on it with the X10 objective before commiting yourself to a purchase. The hole defined by the iris should be dead central. More sophisticated instruments have a floating substage with two or three centreing screws sticking out from around the mount. Be careful when undoing these as some condenser mounts rest on the ends of these screws which butt onto a tapered ring, and the whole assembly may suddenly drop down if loosened too far. Above all check that the condenser lens surfaces have not been scratched in any way, and that the threads of the centreing screws, if present, have not been stripped.

The IRIS DIAPHRAGM is usually fixed in the same mount as the condenser lens and is centred with it. It may be operated by a lever or a knurled-ring. In either case these should not be too loose or make a crunching noise, the latter being suggestive of buckled leaves. In lever operated models the lever may sometimes get in the way. This is usually because the condenser unit is wrongly sited in its clamp. It may be necessary to loosen the clamp and rotate the unit so that the iris lever clears the substage rack along its full range of adjustment. A FILTER/STOP HOLDER is often fixed to the same mount beneath the iris. To load a filter or stop this is swung to one side revealing a ring with a ledge onto which a filter can be dropped. The use of filters will be discussed later, but it is as well to note at this juncture that one of the commonest obstructions to the light path is a filter holder that has swung out of alignment. It may be necessary to tighten its mounting screw or replace a spring washer if it flops around too easily.

The other two lens systems occur above the stage and are mounted at either end of the BARREL. As they have to be used at a fixed distance from each other the barrel is mounted on a rack and pinion driven block so that both units move in unison parallel to the optical axis. This movement is necessary because the depth of focus is so shallow at the magnifications used with the compound microscope that the focus has to be adjusted for each specimen, and at the higher magnifications has to be racked up and down so that the focal plane ranges through the depth of the specimen to allow the brain to synthesize a 3-D impression of the object. Most microscopes have a dual rack system with a pair of large knurled-knobs operating a coarse rack and pinion and a pair of small knurled-knobs operating a very fine adjustment, usually with a total range of only 1.0mm for scanning slowly through the thickness of the specimen. The coarse rack should be smooth in its motion. Any crunching noise will either indicate a loose rack (held by two screws at the

ends) or a chewed-up pinion, rack or both. If buying second-hand pay particular attention to the racks, particularly the fine adjustment. This may not be based on a rack; it may have a system of gears or a lever and slot mechanism. As with the coarse adjustment movement should be free and smooth. Focus an object with the X10 objective and check for stability. Very often the image will slowly drift out of focus as the weight of the barrel and lenses causes the rack to fall against the pinion. Some microscopes have a row of screws on one side of the rack mounting block that impinge on a plate in a slot inside the block. Tightening these screws evenly all the way down will spring the tapered tongue so that it is more effectively gripped by the matching groove in the pinion mounting block. Alway keep this tongued groove lightly greased to ensure smooth movement. Some microscopes control the slip on the rack by friction on the pinion shaft. If one of the knurled knobs has a plastic or neoprene washer behind it then this adjustment is probably made by counter-rotation of the pair of large knobs, the washer being compressed to tighten the mechanism. If after correcting the coarse rack the slip is found to be due to the fine adjustment, the microscope should be taken to an expert to deal with. Unfortunately the fine adjustment is more vulnerable than the coarse one and care should be taken in checking it out before a second-hand purchase.

At the base of the barrel are mounted the most complex lenses, the OBJECTIVES. These contain a sandwich of differently shaped lenses made of glass of differing refractive index to achieve a high magnification and at the same time to correct for spherical and chromatic aberration. More recently computer designed objectives have been developed that can in addition give a 'flat field' so that the entire field of view is in focus, unlike earlier types which are only clearly in focus in the centre of the field. If you are buying a new microscope and can afford it they are well worth it. The matching eyepieces are wide aperture and have a bloomed surface to stop them acting as a mirror.

In all modern microscopes the objectives are screwed into a rotating turret or nosepiece so that they can be swung into place in turn at the base of the barrel. A given set of objectives should be matched so that when an object is located, centred and focussed on the lowest power objective, it should also be centred and approximately in focus for all the other objectives on the turret. In the earliest microscopes fitted with an objective nosepiece the objectives were not par-central or par-focal however, furthermore since the objectives can be unscrewed and as the threads are standard for several makes of microscope, it is possible that a second-hand microscope may have a set which is not matched, a point well worth checking before it is too late. When buying a second hand microscope you will usually be offered a X10 and a X45 objective ('low power' and 'high power') with an option on an oil immersion X95, depending on your pocket. If you are short of cash buy a X2.5 or a X4.5 instead of the X95, as such a wide angle objective is ideal for bryology. It enables you to look at a large area and encompass the whole plant in the case of small species and sizeable shoots of larger ones so that the pattern of branching and disposition of the leaves can be clearly seen, and suitable leaves in a leaf scatter preparation can be selected for examination at higher magnification. It is the next best thing to a binocular dissecting microscope. If you do purchase a X95 it is best kept in its carton when not in use. This lens is really only necessary if you want to look at chromosomes or the texture of oil bodies for example, the X45 generally being quite adequate for taking cell or spore measurements.

When buying objectives check them out thoroughly as they are the most crucial parts of the microscope. A tiny scratch or pit on the lower surface of the basal lens will not be seen as such when looking down the microscope: it will merely cause a loss in definition so that the image appears slightly misty. Examine them in reflected light, tilting against the light to throw a shadow from any blemish. If they are dirty insist they are cleaned and

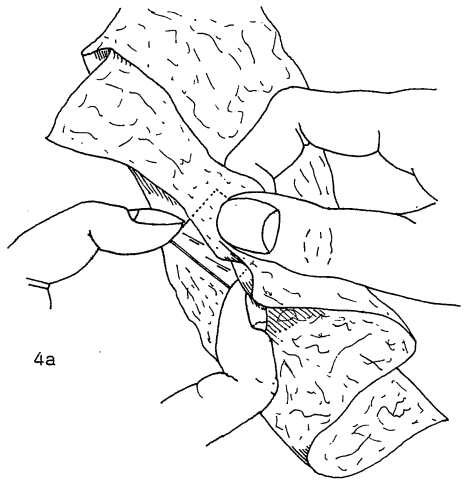
look again. Next look through them at a brightly illuminated scene - if they are not crystal clear - don't buy them. If you already have objectives on a microscope and they are clean and unblemished they may still give trouble if the black lacquer inside is beginning to flake and fragments drop down onto the lens. This again will not be obvious as a flake but will result in a slight mistiness and loss of resolution. Dislodge any flakes by tapping the objective upside down on a table, rather than try and poke anything down inside which might scratch the lens. Canada balsam and other residues can usually be removed with xylol substitute (xylol or xylene is now regarded as a carcinogen and banned in educational establishments). If an objective still appears mirky after cleaning and after examining the inside another possibility is that immersion oil, Canada balsam or a solvent of some kind has penetrated the cluster of lenses that constitute the objective, rendering it useless and almost certainly irretrievable.

The lens system atop the barrel forms the EYEPIECE or OCULAR. Monocular microscopes generally have several eyepieces that can be interchanged for use with different objectives. There are several makes of 'mini-microscope' on the market that have tiny lenses that are extremely tiring to use, because the image can only be projected onto a small area of the retina. Although they have a comparable magnification to larger models, their resolution is poor. They are not even suitable as toys for children as they find them even more difficult to use than adults. Always go for a microscope that has wide aperture eyepieces and objectives. Choose an ocular that has an aperture of at least 8mm and preferably more. If you can only afford one, a X8 is a good compromise, but a X6 plus a X12 is reckoned to be the ideal combination. If you already have a microscope or are thinking of buying one, an absolute essential for the bryologist is an EYEPIECE MICROMETER (Graticule). It consists of two glass discs cemented together with a wafer thin replica of a scale sandwiched inbetween. It is inserted inside the ocular by unscrewing the top lens and and dropping it down onto an annular ledge placed there for the purpose. This ledge lies at the principal focus of the lens system so that an image of the scale is superimposed on the image of the specimen on the stage, thus making possible relative, and when suitably calibrated with a MICROMETER SLIDE or STAGE MICROMETER, absolute measurements of the specimen. It is a good idea to buy an eyepiece micrometer scale when buying your microscope. If you already have an eyepiece take it along to the shop to check a) that the disc will indeed go down inside your ocular, and that b) it is in sharp focus when you look through it. Various types of scale are available with grids or linear scales. The best for bryology is a 1cm linear scale divided into 100 units numbered every 10. Always buy a new one as they easily get scratched and being placed at the principal focus the scratches will show and detract from the image. One useful tip. Very often the barrel of an eyepiece has an identical thread either end and it is possible that that the top and bottom lenses have been reversed. This will alter the relative position of the ledge making it impossible to focus the scale. The top surface of the ledge should be flat, any flange projecting downwards, away from the top lens. Finally never try and fit a micrometer eyepiece scale into a flat-field ocular. These are multi-element lenses that must not be taken apart and do not have a graticule ledge.

4. SETTING UP A MICROSCOPE:

Let us suppose that you have just purchased a second-hand microscope, complete with eyepiece graticule, but have no instruction booklet to help you to use it. First of all you will need some further accessories in order to study bryophyte material. Microscope slides and coverglasses are essential. Slides are produced as a standard 76 x 26mm, but coverglasses are available in a variety of sizes, and can be square, round or rectangular. Round ones are probably the most useful for bryology, as they are easier to

seal reliably than angular ones. A useful combination is a box of 13mm diameter glasses for general use, and a box of 22mm for permanent mounts of larger specimens. Objectives are designed for use with standard 1mm thick slides and with a particular thickness of coverglass. A coverglass that is too thick or too thin will cause quite noticeable spherical aberration. To minimise this possibility use No.1 coverglasses unless your microscope manual specifies otherwise. You will also find at least one pair of needle-pointed forceps essential, a good make being IDEALTEK No.3. The points are so fine that they will need protection when not in use. Hold with the points together and push into a small cork when finished with and they will last for years. If you can afford to buy two pairs they are well worth it, as they can be used one in each hand for teasing strands of mosses or liverworts apart and for holding delicate stems when stripping back a tiny leaf. Another accessory that is again most useful as a pair and is easily made, is the mounted needle. Break off the eyes from two darning needles by placing the eyed ends in a vice and flexing the needles with pliers. Then clamp each needle in turn in the vice, blunt end exposed, and carefully push onto them 10cm lengths of 5mm diameter softwood dowel. Other items you will need later on are a packet of double edged disposable razor blades, a cheap small paint brush and a margarine tub filled with clean water. Also, unless you are prepared to use your thumb for cutting sections against, as I do, you will need some elder pith or a fresh carrot. Elder pith is useful to stock-in as it saves searching for a carrot every time you want to cut a section. Seek out an Elderberry bush with stems c.½"diam. and break off a stem of this size. Cut into lengths of about 5cm and push out the pith with a piece of dowel. The pith will squeeze up almost to nothing and then pop out regaining its shape.



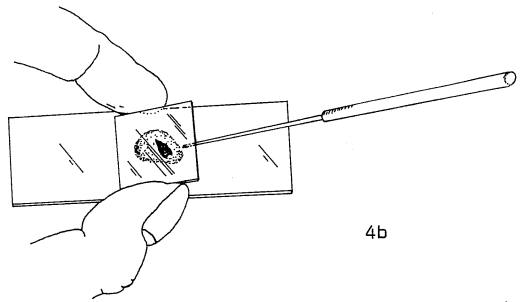
4a

With these items at the ready start by polishing a slide to remove all dust and grease using a clean tissue or hankerchief. Then polish a coverglass. This is far from easy as they are very fragile. Hold as in 4a and rub both surfaces simultaneously under even pressure in a fold of tissue between thumb and forefinger. Then put it somewhere obvious, so that you can refind it when required. Being transparent they are easy to put down and lose until broken fragments turn up in someones hand.

Place a small drop of water in the centre of the slide by dipping a finger in the water. Now strip off a leaf from say a Mnium (which has large clear cells) with the forceps and place it in the drop. Then take the coverglass and lower it (4b) onto the drop from one side supporting the leading edge on a mounted needle. It is as well to practice this procedure so that a) you can judge the size of the drop needed to just fill the gap between the slide and the coverglass without running out along the edges, and b) so that you do not entrap any air bubbles. When later on you come to make permanent or semi-permanent mounts you will find that material oozing from the edge is difficult to remove, and too much mountant results in a thick preparation, while air bubbles are very difficult to remove from a viscous mountant. An excess of water in a temporary mount can also give problems. If

the microscope is tilted towards the observer, the water will drain down the slope of the slide carrying small specimens with it, and sometimes the coverglass as well. When using water mounts on a cold day a further problem may arise if excess water is present on the slide. For no apparent reason it may suddenly become impossible to focus the X45 objective. This is usually due to the rapid condensation of water vapour on the cold surface of the objective lens that has evaporated from the slide due to absorption of thermal radiation from the lamp. No amount of wiping the lens will cure the problem until either the microscope warms up, or the free water surface on the slide is removed.

While on the subject of cleaning lenses, always use proper LENS TISSUES to clean both the objective and ocular lenses. The cotton, wood and other plant fibres used in tissue-wipes and handkerchiefs are hard and will scratch the soft optical glass of all but some of the latest Zeiss lenses, and are disasterous on the blooming of flat-field oculars.



4b

Having mounted the specimen in water, tilt the microscope towards you until it is comfortable to use, then open the iris diaphragm fully and swing the X10 objective into position. All objectives should lock firmly in place when aligned with the optical axis of the barrel. If they do not check to see if the catch that secures them can be improved in any way. Now place the slide on the stage, specimen and coverglass uppermost, so that as far as you can judge looking from the side, the specimen is in the centre of the hole in the stage. Again, practice in doing this can save time in the future; one acquires the knack after a while of being able to place a specimen in the tiny area of the field (c. 2mm diameter) seen by the X10 objective.

Now angle your lamp to the horizontal, tilt slightly downwards and bring up close to the microscope, aiming the light at the substage mirror and making sure that no light strays above the stage to illuminate the specimen in reflected light. Remove the eyepiece from the barrel and, looking down the barrel, twist the mirror around until the image of the light bulb is centred in the objective lens, moving the light around as well if necessary. Then replace the eyepiece and attempt to focus the microscope on the leaf. The X10 objective should focus at around 16mm above the slide. Use the coarse adjustment initially and then the fine focus to get it really sharp. Sometimes the fine focus adjustment comes up against its stop and annoyingly cannot be turned far enough to bring the image into sharp focus. To correct this situation rotate the fine focus knob fully in the opposite direction and then refocus with the coarse adjustment. You will now have plenty of travel on the fine adjustment to move it through the focal plane.

Now that you can see your specimen you will want to hold it in position. If your stage is a simple one with two clips, hold the slide firmly in one hand and secure with one clip, making sure that the clip

does not come down on the coverglass, then still holding firmly flip the other clip in place. The clips should be easy to position but firm. If too tight remove from the stage and bend the tips upwards slightly with the fingers, or if they are too loose, bend the tips slightly downwards.

Many microscopes have a mechanical stage to move the slide in the X and Y directions operated by knurled-knobs. Many beginners become so frustrated trying to 'navigate' a slide in the opposite direction to that of the image that they feel a mechanical stage is a must when seeking to purchase a microscope. In fact, mechanical stages are often poorly designed and soon fall apart or become exasperatingly sloppy. They are also very susceptible to becoming gummed-up when in continual use and are difficult to keep clean and at the same time lubricated. For the experienced bryologist a plain stage is no handicap, in fact its very freedom is a distinct advantage. A slide gripped between the thumb and forefinger of one hand can be moved rapidly sideways or rotated freely to any desired angle while continuously monitoring with the fine focus manipulated with the other hand. The skill to move the slide in the opposite direction to the image is soon acquired with a little practice. The mechanical stage only really comes into its own when regular unbiased scoring of pollen or cell frequencies by successive scans is required, or to relocate a particular cell in a cytological preparation using the coordinates on the stage scales.

Although you may be able to see your leaf clearly, it is unlikely to be optimally illuminated and you may well be seeing optical artifacts. To ensure these are absent and the specimen is evenly illuminated the sub-stage condenser lens and iris diaphragm have to be critically adjusted. First of all check that you are using the flat side of the mirror. Never use the concave side, it will produce an astigmatic beam, the rays hitting the front of the mirror being brought to a different focus from those hitting the back. If daylight is bright enough, use it with the flat side of the mirror, if not, use the flat side with an electric lamp.

Raise and lower the sub-stage condenser until the bars of the window (daylight) or the lettering on the electric bulb are sharply focussed and superimposed on the image of your specimen. To finally remove these telescopic effects bring the condenser down very slightly. The job of the condenser lens system is to bring the light beam down to a cone that will match the objective aperture (see 3a) thus giving both bright and even illumination of the specimen on the slide. As the iris diaphragm is shut down it alters the angle of the cone so that the specimen is illuminated by a bunch of light rays of decreasing angle. You will notice a marked change in the appearance of the specimen as you close the iris. If closed too far the angle of the cone is so narrow, that shadows are cast by the cell walls; while this helps you to see cell outlines it gives the walls a greater apparent thickness, -an unreal thickness. To prevent these artifacts remove the eyepiece again and looking down the barrel adjust the iris so that about three-quarters of the back focal plane of the objective is filled with light. It is a common fallacy that the brightness should be controlled by adjusting the iris, or worse still the condenser. It should be controlled at the source, either with a rheostat or thyristor dimmer, an opal perspex filter, or a less powerful bulb.

Having had a good look at your leaf with the X10 objective, select a particular area, register it in the centre of the field and bring into sharp focus. Now attempt to swing the X45 objective into position. For the the first time do so with caution, check from the side to see that it will not crunch into the slide. It should clear the coverglass by 0.5 to 1.0mm, its working distance (not to be confused with its focal length), and be almost in focus. If your set of objectives is not par-focal

then you will have the laborious task of focussing each objective independently each time you want to use it. If this is the case it will help to determine the working distance for each one, that is the distance between the bottom lens of the objective and the slide when in sharp focus. With the X45 this means carefully racking down as close as you dare to the coverglass, while watching from the side, and then slowly racking back up while looking down the microscope until the image suddenly appears and you can focus it. The slightest hesitation about which way to turn the focussing knobs for 'up' or 'down' and the objective can go crashing through the coverglass, or even worse, through the slide. Such an event could scratch and write-off both the objective and sub-stage condenser lenses, hence the importance of buying where possible par-focal sets of objectives. Otherwise the user must practice until 'up' and 'down' become instinctive, and must always position the X45 and X95 lenses by watching from the side and rack up only to focus.

Most older microscopes are fitted with a 'draw-tube' to adjust the distance between the ocular and objective lenses to correct for differences in coverglass and mountant thickness that would otherwise result in spherical aberration. The draw-tube is not easy to adjust as the thickness of the mountant beneath the coverglass is generally unknown. Most objectives however are corrected for a 160mm tube length in association with a standard 0.17mm coverglass. Modern microscope designs have largely dispensed with this adjustment and have a fixed tube length, but the better ones have a correction collar that can be fitted to each objective. For the beginner it is probably best to stick to the standard tube length engraved on each objective, as spherical aberration of the image at this setting will only be appreciably apparent with very delicate material.

Because the X45 objective comes into focus much closer to the slide than the X10, the cone of light passed by the iris diaphragm will be intersected at a lower plane, so that with a setting that fills the back lens of the X10 objective, the X45 will not be adequately illumined. To compensate the eyepiece should be removed and the iris diaphragm opened until the objective is just filled with light.

Having adjusted the microscope so that you know how to use the X10 and X45 objectives and critically illuminate them, you may be feeling some eyestrain. This is generally caused by trying to look down the microscope with the other eye closed and by focussing the image as if it were only 10 inches or so away, the normal reading distance. To use a microscope for any length of time the only way to avoid eyestrain is to keep both eyes open. Like driving a car this takes some practice but after a while you will become so engrossed in your specimens that you become oblivious to the image of the barrel in the other eye. It is also helpful to relax your eyes and focus them at infinity, changing the focus of the microscope to suit your eyes rather than the other way round.

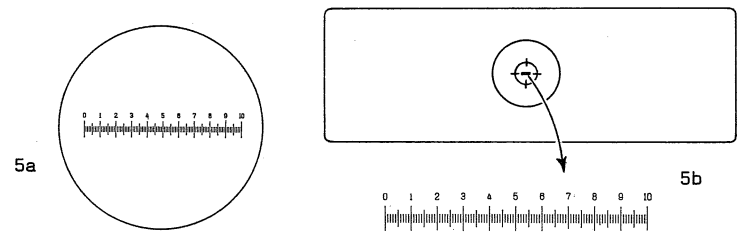
If your microscope is fitted with X2.5 or X4 objectives there may be a problem in evenly illuminating the field of view. Some microscopes have a wide angle substage condenser for low power objectives and a flip over supplementary lens for high power work. Others have an accessory condenser lens that can be fitted for low power objectives, or the top lens of the condenser may unscrew. Only the first of these alternatives is convenient for general observation, although it would of course be worthwhile changing a condenser or unscrewing the top lens for photographing a particular specimen. To produce a reasonably evenly illuminated image for general observation of a plant at low power, prior to a more detailed examination under the high-power objectives, the light can be dispersed by using a ground-glass screen. This is easily made by

rubbing together two 4 x 4cm coverglasses, as used for mounting 35mm slides, with a slurry inbetween of fine carborundum powder in water; until when washed and dried, one of the glasses appears evenly ground. The resulting ground-glass screen can be placed on the ring of the filter holder when using objectives with a magnification lower than X10.

5. CALIBRATING AN EYEPIECE MICROMETER:

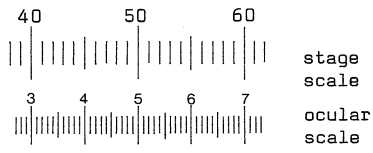
Assuming that you have successfully fitted an eyepiece micrometer scale into your eyepiece, it will be possible to use it for measuring the relative lengths and widths of cells, a ratio commonly used to distinguish one species from another. The scale can be lined-up along the length or breadth of a particular cell simply by rotating the eyepiece. For absolute measurements however the bryologist must calibrate his micrometer eyepiece scale with an absolute scale placed on the stage in lieu of the specimen.

For cell and spore measurements the unit used is the micrometer (μm), one millionth part of a meter (= one thousandth part of a millimeter). This unit is the same as the old 'MICRON' and its symbol 'μ' (pronounced 'mu'), a meaningless unit in a modern setting. In Dixon's Student's Handbook of British Mosses some of the measurements are given in 'LINES'. This unit is the old 'PARIS LINE', twelve times the thickness of a human hair, said to be equal to 2.25mm! All present day measurements in bryology are based on the more reliable metre. Centimeters and millimeters for whole plants and leaves, micrometers for cells and spores, and nanometers (10^{-9}m) for sub-cellular structures.



To calibrate the eyepiece micrometer (5a), it has to be compared with a standard stage micrometer (5b). The latter consists of a slide on which has been mounted a tiny photographic replica of a precision scale. For bryological work one with a 1.0mm scale divided into tenths and hundredths is convenient (5b). This is essentially a microscopic ruler marked out in 10μm (1/100mm) intervals, on which for example a leaf could be placed to measure its cells directly. For convenience however the arbitrary eyepiece micrometer scale is calibrated instead. To calibrate, line-up both scales transversely across the centre of the field of wiew, as closely superimposed as will allow you to distinguish between them, and then move the stage micrometer slide until the mid-point division lines up with the mid-point division of the eyepiece scale. This is preferable to lining them both up from one end as uneven curvature across the lens system may cause errors. In the example (5c), it can be seen that 40 eyepiece units (E.P.U.) are equal to 20 stage micrometer units (=20 x 10μm = 200μm) thus one E.P.U. = 200/40 = 50μm. At higher magnification only a small segment of the stage micrometer scale will be seen in the field of view. The two scales are unlikely to fit exactly so that the units of one are integral multiples of the other, necessitating estimation of fractions of units. If your microscope has a draw-tube however this can be raised to increase the magnification of the stage micrometer scale relative to the eyepiece scale until the two scales line-up. It does mean however, that in order to measure anything again your calibration will only be correct for that draw-tube setting.

The same will of course apply to the particular objective and eyepiece that you are using. In short, anything that changes the magnification will change the relationship between the scales. The best way to deal with the problem is to make out a table specifying the value of one, two, three ....n, eyepiece units in μm for the X10 objective and the X12 eyepiece at a specified draw-tube distance and similarly for the X45 objective and X12 eyepiece, and any other lens combination you intend to use.



5c

Having measured some cells you may wish to relate these values to a scale drawing in an identification guide. When a drawing of a plant is given as, say X400, this means that the dimensions of the drawing are 400X actual or life size. It does not mean the product of the objective and eyepiece magnifications of the microscope used to make the observations, as some students would have us believe. This way of indicating size is very irritating to use, as to appreciate the actual size of a cell or leaf one has to measure the size of the item on the drawing and then divide by 400 to obtain its actual size, at the same time keeping one's fingers crossed that the printer has reduced the artist's drawing by the right ratio for the magnification factor to be correct. A far more overt way of indicating size is by adding a scale bar (preferably sub-divided) to the drawing, either, mm or μm as appropriate. It is also a safe way of ensuring that the printer gets it right. In both cases however one can make a small card ruler marked out in micrometer equivalents and keep it with the book. For example if the scale is X400, a 10μm cell will be 4mm at the scale of the drawing. Thus by marking a card edge with a fine pen at multiples of 0.4mm intervals this can be used to read off sizes in micrometers.

This account is only intended as a brief non-technical introduction, which endeavours to foresee some of the pitfalls likely to plague the beginner and his microscope. For a more technical and extensive account of the whys and wherefores of microscopy the reader is referred to the book 'Hartley's Microscopy' by W. G. Hartley, 2nd edition 1979. The Senecio Press Ltd., Charlbury. England. ISBN 0 906831 00 8.

MICROSCOPY ACCESSORIES SALES AND SERVICE:

As many members seem to be having difficulty in obtaining hand-lenses, fine-forceps, and stage micrometer slides, the Librarian is prepared to supply these at the current retail prices from suppliers in London, if there is enough demand for a bulk order. Prices quoted are approximately those as at going to press. Please make any enquiries, without sending cash, by the 31st March.

HAND-LENS Swift. X20 achromatic, stainless steel frame, and leather case. £11

NEEDLE POINTED FORCEPS Idealtek. Size 3 ..... £3

A Stage Micrometer Slide with a 1mm scale subdivided at 10μm intervals can be loaned for calibrating eyepiece micrometer scales on receipt of a £15 returnable deposit. Write to: The BBS Librarian, 63 Wroths Path, Baldwins Hill, Loughton. Essex IG10 1SH.

SCOTT'S MOSSES - AN EARLY NINETEENTH CENTURY BRYOPHYTE COLLECTION FROM CHATSWORTH

W.D. Foster and M.A. Pearman

In the summer of 1979 one of us discovered in the library at Chatsworth two small boxes containing bryophyte specimens mounted on sheets of paper. The boxes are labelled on the outside, in what appears to be an early 19th. century hand, "Scott's Mosses". In all there are 93 sheets upon which are mounted 95 specimens of bryophytes, both mosses and liverworts. Each sheet measures 20 x 12.5 cms and the name of the species is written on the bottom in a similar early 19th. century hand. Localities, which are always of the briefest, are given for 60 of the specimens - all are either from the Chatsworth estate or very close by. The main interest of the collection is that no less than 4 of the 60 localized species have never been recorded from Derbyshire. The collection also provides evidence of changes in the bryophyte flora of the Chatsworth estate since the collection was made, since a number of species gathered by Scott can no longer be found in his localities.

The date of the collection.

We believe that the collection was made sometime between 1836 and 1855 for the following reasons :

1. The nomenclature used corresponds well with that of the 2nd. edition of Hooker and Taylor's "Muscologia Britannica", published in 1827 and is quite different from that of Wilson's "Bryologia Britannica" which was published in 1855.
2. The collection contains a specimen of Orthotrichum rupestre (called O. rupinicola in conformity with Hooker and Taylor). This moss was first noted in Britain by M.J. Stark of Glasgow and reported by Hooker and Greville in 1824 (1)
3. The collection also contains a specimen of Cinclidium stygium labelled "Cinclidium species". This moss was first discovered in Britain by John Nowell, in a bog near Malham Tarn, Yorkshire in 1836.

It seems to us therefore that the collection was named by a competent bryologist (the species are very accurately named) between 1836 and 1855.

Who was Scott ?

We have been unable to identify Scott with certainty but believe that he was a Robert Scott, a Chatsworth gardener, in the 1840's. Scott held a position there of some importance as "Superintendent of the plant department in the large conservatory", a conservatory that, at the time, was the largest glass building in the world and contained a vast array of tropical and sub-tropical plants. The evidence suggests that this Scott was an expert botanist who might well have been capable of identifying the collection of bryophytes. There is, for example, a collection of lichens and another of orchids clearly labelled in the same hand as the bryophytes, and dated between 1828 and 1846. There are also three interesting contributions to Paxton's Magazine of Botany for 1849 by Robert Scott. (2,3,4,) These papers clearly

show that Scott was a well-educated, thoughtful botanist. One of the papers is on a method of raising tropical ferns from spores and another on a method of getting a Malayan genus of orchid, Renanthera, to flower in a greenhouse. But the most interesting of the papers is that entitled "Observations on a singular variety of Plantago major called 'Besom Plantain' of Ray". This variety of Plantago major, in which the bracts appear foliaceous, had first been discovered by Dr. Johnson, on the Isle of Thanet in 1632, and had since been noted in several parts of the country. Scott had cultivated the seeds of this plant through a number of generations and noted that the foliaceous bracts persisted and that the plant showed no tendency to revert to the ordinary form of Plantago major. Scott's comment on this phenomenon is of interest as a reflection by a practising and thoughtful botanist on the "species question" a decade before the publication of Darwin's "Origin of Species". Scott remarks, "Here we have a peculiarity produced originally by a favourable concurrence of climate or other conditions, observed in a common plant more than 200 years ago, and since found in various parts of the country, becoming fixed, and that too in the absence of any care on the part of man. These facts open a wide and interesting field for physiological and botanical inquiry".

The Chatsworth estate account books contain a number of references to payments made to Robert Scott between 1845 and 1847 such as "for expenses in collecting plants - 10/6" and "expenses to Gainsbro' for a plant - £1-3-6". There is also an incomplete and unsigned letter in the Paxton correspondence endorsed as from a "Mr. Scott". This letter is dated from Calcutta on May 31st, 1860 and is pretty clearly from an ex-employee of Chatsworth excusing a delay in sending back some plants. Scott would not have been the first Chatsworth gardener to have been sent out to India to collect plants for the garden. In 1835 the 6th Duke of Devonshire sent out John Gibson to collect specimens of Amherstia nobilis(incidentally the subject of much of the Scott letter to Paxton) (5) It also appears that, in 1843, the Duke had been asked by Professor John Lindley to recommend a gardener for the Calcutta Botanical Gardens. There is in the Chatsworth archives a letter from the Duke to Paxton in which he writes. "Dr. Lindley has just been making enquiries whether Gibson would like a thing that very probably will be offered to him. To be gardener at Calcutta with £240 a year and a house provided. Very grand, but I shant be surprised if he prefere Baslow - you must find out skilfully from him, and let me know. If not I am sure Dr. Lindley will appoint any body recommended by me." Gibson did not accept the offer; he moved to London as superintendent of the Victoria Park in 1849. It seems not unlikely that, failing Gibson, Robert Scott was persuaded to take the job, and there was indeed a Robert Scott who collected plants in Burma in 1855 (and the Scott who wrote to Paxton appears to be familiar with that country) and then moved on to Calcutta where he remained until 1865. (6) On this by no means conclusive evidence we ascribe the Chatsworth bryophyte collection to Robert Scott, a gardener there in the 1840s.

The Bryophyte Collection.

Of the 60 specimens with named localities 55 were collected on the Chatsworth estate or very close by. E.g. Old Park, Pinetum, Arboretum, Kitchen Garden, Emperor Pond, Beeley

Moor etc. The remaining 5 came from the Buxton area. The four mosses not previously recorded from Derbyshire are as follows: Grimmia patens from Old Park, Pterigynandrum filiforme from Ashford near Bakewell, Tetraplodon mnioides from Beeley Moor and Bartramia hallerana from the moors near Buxton. Although Tetraplodon mnioides has been recorded from as close as Cheshire, the nearest records of the other three species are North Wales or the far north of England; their range was therefore appreciably greater in Scott's day.

There are some species which, although they have been recorded in Derbyshire, can no longer be found on the Chatsworth estate in the localities given by Scott. No attempt has been made to refind all Scott's species in his localities but, for example, a search has failed to find Orthotrichum pulchellum in Stand Wood, Cryphea heteromalla or Ulota crispa on Beeley Moor, or Antitrichia curtipendula and Frullania tamarisci in Old Park. A parallel decline in the corticolous lichen flora of this area has been noted by Hawksworth. (7)

Of the remaining specimens in the collection only one is ascribed to a particular locality; this is a duplicate specimen of Splachnum sphaericum from the "Grampians", but this sheet is marked with the initials "N.B." which perhaps suggests that it was collected by some other person. Most of the remaining bryophytes are unremarkable species but among those specimens with no given localities are three worth mentioning: Splachnum ampullaceum, Gymnomitrion crenulatum and Pleurozia purpurea - if a Derbyshire locality had been given, all would have been new records for that county. It is not hard to believe that Splachnum ampullaceum occured near Chatsworth - indeed it is surprising that it has never been recorded from Derbyshire since it has been found in both Staffordshire and Cheshire. Nor would it seem impossible that Gymnomitrion crenulatum might have grown in the vicinity 150 years ago since its favoured habitat and present day geographical distribution are very similar to those of Pterigynandrum filiforme. However Pleurozia purpurea is another matter. This markedly Atlantic species is practically confined to the north-west of Scotland and its present day most southerly station is Kirkcudbrightshire; it is not recorded at all from England or Wales. It is hard to believe that this liverwort could ever have grown in Derbyshire and we must therefore conclude that Scott was able to travel far afield in his pursuit of bryophytes or had a correspondent in the north-west of Scotland or the west of Ireland.

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1. Hooker, W.J. & Taylor, T. (1827). "Muscologia Britannica", 2nd ed. p.127.
2. Scott, R. (1849). Paxton's Magazine of Botany, 16, 120.
3. Scott, R. (1849). Ibid 16 135.
4. Scott, R. (1849). Ibid 16 236.
5. Coats, A.M. (1969). "The quest for plants", London, p.154.
6. Desmond, R. (1977). "Dictionary of British and Irish botanists and horticulturists", London, p. 548.
7. Hawksworth, D.L. (1974). "Report on the lichen flora of the Peak District National Park", Shrewsbury.

LINDBERGIA

We have had a note from Dorte Boesen, Treasurer of Lindbergia, indicating that anyone subscribing to that journal can pay by sterling cheque drawn on their personal bank account since this is readily cashed in Copenhagen. In other words, it is not necessary for British residents to pay dollars - an ordinary cheque in sterling equivalent being perfectly suitable.

JOURNAL OF BRYOLOGY VOL.11 PART 2

Owing to circumstances beyond the control of our editor, Dr A.J.E. Smith, this will not appear until March or April, 1981.

SATURDAY OPENING OF THE DEPARTMENT OF BOTANY AT THE BRITISH MUSEUM (NATURAL HISTORY)

As from 1 January, 1981 the Department of Botany will be open on Saturdays only to assist visitors who have given reasonable advance notice by letter or telephone to the Head of the Section concerned; no service will be provided for visitors who arrive without prior notice. BBS members should contact Mr A. Eddy (ext. 411) or, in his absence, Dr A. J. Harrington (ext. 556).

REQUEST FOR MATERIAL

I am studying aspects of the reproductive biology and genetics of Archidium alternifolium and would appreciate living material from a range of populations. Specimens, which need not have sporophytes, should be posted in a polythene bag inside an envelope. Postage will be refunded.

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